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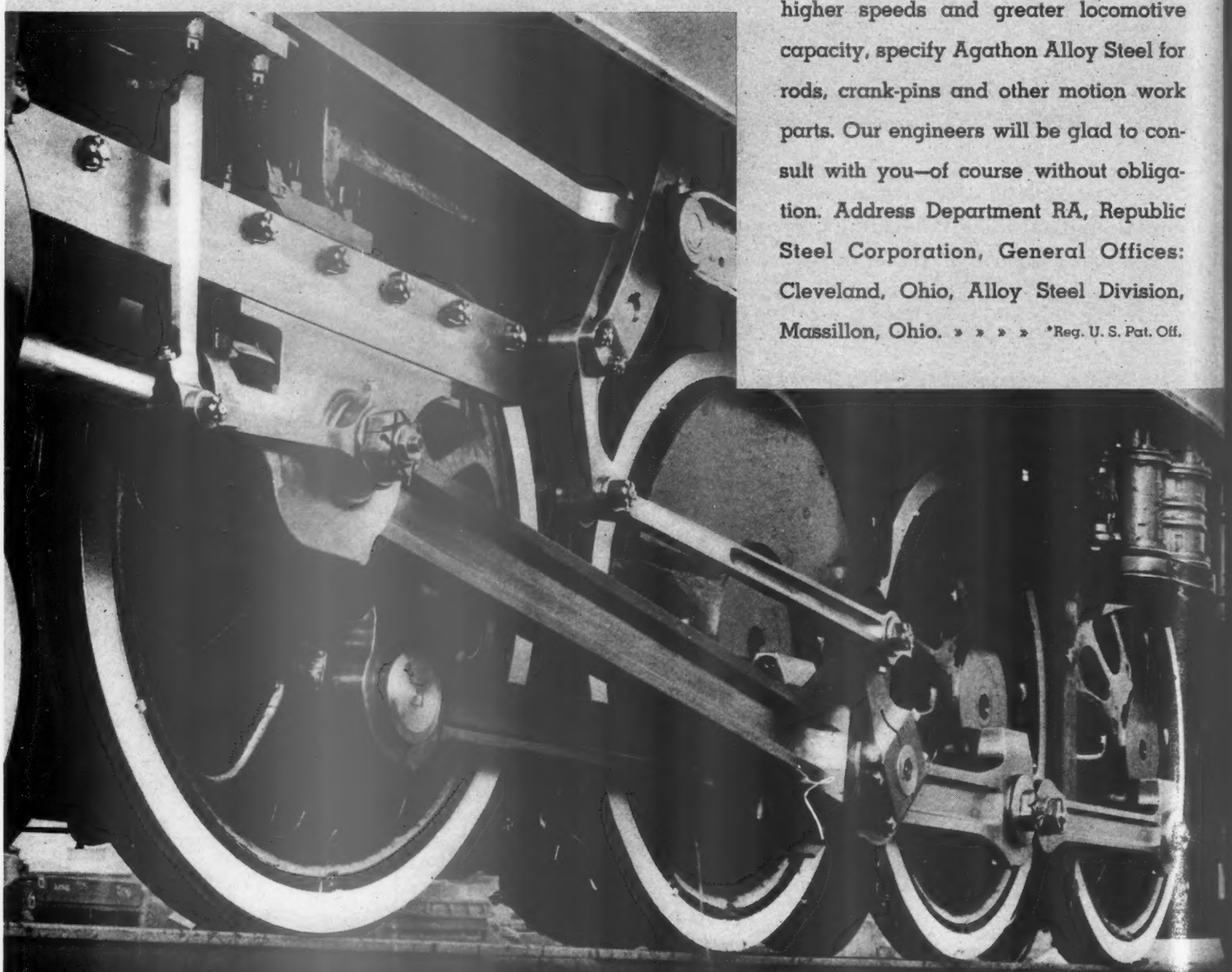

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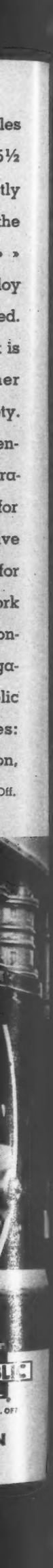


The New York Central Receives Fifty

Powerful 4-6-4 Locomotives

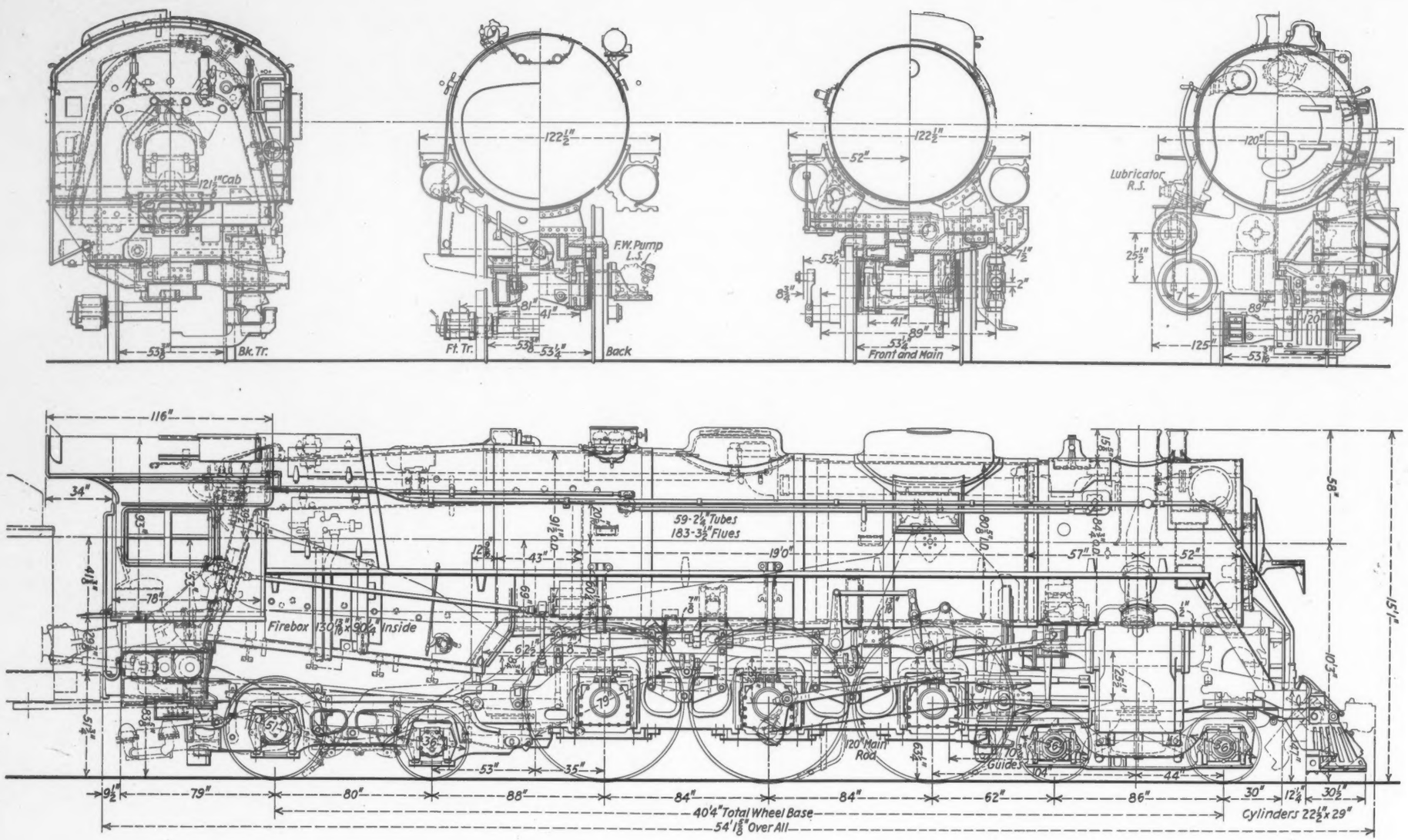
These locomotives, built by American, develop a total tractive force of 55,540 lb. and a maximum drawbar horsepower of 3,380 at 65 m. p. h.—The boilers have combustion chambers and all-welded fireboxes

SINCE the latter part of 1937 the New York Central has been taking delivery from the American Locomotive Company of an order of 50 locomotives of the 4-6-4 type, the last 10 of which are streamline. These locomotives, which are known as the J-3a class, are similar in general design to the earlier 4-6-4 type locomotives of the J-1 class, the first of which were delivered to the New York Central by the same builder in 1927. In mechanical details, as well as in boiler proportions, however, the design is characterized by distinct refinements. The weight of the new locomotives has been increased by four-tenths of one per cent and the weight on drivers by about three per cent, as compared with the most recent J-1 design. The boiler proportions have been materially changed by the insertion of a 43-in. combustion chamber and by reducing the length of the smokebox to permit moving the tube sheet 25 in. forward. The length over the tube sheets has been reduced by 18 in. to 19 ft. and the boiler pressure has been increased from 225 lb. to 275 lb. per sq. in. The boiler courses are alloy steel.

The Boiler

With the insertion of the combustion chamber the form of the boiler has been slightly changed from the straight-top type employed in the J-1 locomotives. The inside diameter of the first course has been reduced $1\frac{13}{16}$ in. to $80\frac{5}{8}$ in. The second course is conical. The outside diameter of the third course has been increased $3\frac{7}{8}$ in. to $91\frac{1}{2}$ in. The tube-sheet layout has been modified by the installation of a larger number of $2\frac{1}{4}$-in. tubes without, however, essentially changing the number of units in the Type E superheater. The reduction in the length of the tubes, however, has effected a reduction in superheating surface. The shell courses, the welt strips and the dome liner are of nickel steel. The first course is $\frac{13}{16}$ in. in thickness and the others, $\frac{7}{8}$ in. in thickness. The dome, which is on the conical course, is flanged of carbon steel. The wrapper sheet is $\frac{31}{32}$ in. in thickness and the outside side sheets and back head, $\frac{9}{16}$ in.

The inside firebox is completely welded. This includes the tube sheet and door sheet to the crown and side sheets, the door sheet to the back head at the fire-door ring, the crown to the side sheets and the throat sheet to the firebox sheets and combustion chamber. These seams are all joined by butt welding inside and outside.



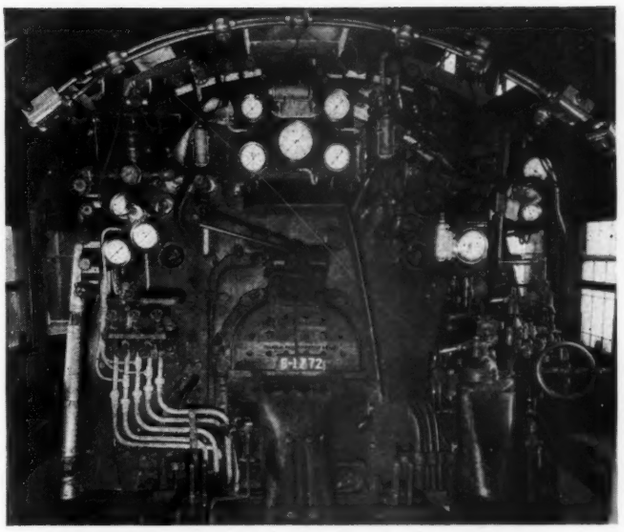
Elevation and cross-sections of the New York Central Class J-3a 4-6-4 type locomotives

The inside and outside side sheets are welded to the mud ring at the corners, and the outside sheet calking edges at both the throat-sheet and back-head seams are welded above the sixth row of staybolts from the mud ring.

Both the front-tube-sheet and the back-head bracing are in the form of gussets, except for three points on the tube sheet and two points on the back head where clearances made necessary the use of rods. The back-head gussets are flanged and riveted directly to the wrapper sheet. The tube-sheet gussets are attached by angles to both the shell and the tube sheet itself.

General Dimensions, Weights and Proportions of the New York Central 4-6-4 Type Locomotives

Railroad	New York Central
Builder	American Locomotive Co.
Type of locomotive	4-6-4
Road class	J-3a
Date built	1937
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	15-1
Height to center of boiler, ft. and in.	10-3
Width overall, in.	125
Cylinder centers, in.	89
Weights in working order, lb.:	
On drivers	196,000
On front truck	66,000
On trailing truck	98,000
Total engine	360,000
Tender	314,300
Wheel bases, ft. and in.:	
Driving	14-0
Rigid	14-0
Engine, total	40-4
Engine and tender, total	83-7½
Wheels, diameter outside tires, in.:	
Driving	79
Front truck	36
Trailing truck	36 and 51
Engine:	
Cylinders, number, diam. and stroke, in.	2-22½×29
Valve gear, type	Baker
Valves, piston type, size, in.	14
Maximum travel, in.	8½
Steam lap, in.	1⅝
Exhaust clearance, in.	3/16
Lead, in.	¼
Cut-off in full gear, per cent	85
Booster	Franklin Type C-2
Boiler:	
Type	Conical connection
Steam pressure, lb. per sq. in.	275
Diameter, first ring, inside, in.	80⅝
Diameter, largest, outside, in.	91½
Firebox length, in.	130 13/16
Firebox width, in.	90¼
Height mud ring to crown sheet, back, in.	68
Height mud ring to crown sheet, front, in.	89 1/16
Combustion chamber length, in.	43
Arch tubes, number and diam., in.	4-3½
Tubes, number and diam., in.	59-2¼
Flues, number and diameter	183-3½
Length over tube sheets, ft. and in.	19-0
Net gas area through tubes and flues, sq. ft.	8.93
Fuel	Bituminous
Stoker	Standard, type H-T
Grate type	Firebar, rocking
Grate area, sq. ft.	82
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	323
Arch tubes	37
Firebox, total	360
Tubes and flues	3,827
Evaporative, total	4,187
Superheating	1,745
Comb. evap. and superheat.	5,932
Feedwater heater, type	Elesco
Tender:	
Style or type	Rectangular water leg
Water capacity, gal.	14,000
Fuel capacity, tons	30
Trucks	Six-wheel
Journals, diam., in.	5.906
General data, estimated:	
Rated tractive force, engine, 85 per cent, lb.	43,440
Rated tractive force, booster	12,100
Total rated tractive force, lb.	55,540
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	54.45
Weight on drivers ÷ tractive force	4.51
Weight of engine ÷ evaporat. heat. surface	85.95
Weight of engine ÷ comb. heat. surface	60.69
Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	6.07
Tube-flue heat. surface, per cent comb. heat. surface	64.52
Superheat. surface, per cent comb. heat surface	29.42
Firebox heat. surface ÷ grate area	4.39
Tube-flue heat. surface ÷ grate area	46.68
Superheat. surface ÷ grate area	21.28
Comb. heat. surface ÷ grate area	72.38
Gas area, tubes-flues ÷ grate area	0.109
Evaporat. heat. surface ÷ grate area	51.06
Tractive force ÷ grate area	529.8
Tractive force ÷ evaporat. heat. surface	10.38
Tractive force ÷ comb. heat. surface	7.32
Tractive force × diam. drivers ÷ comb. heat. surface	578.5



Interior of the cab of one of the streamline locomotives

The brick arch is mounted on four arch tubes. The grates are of the Firebar type and coal is fed by a type HT Standard stoker. The stoker engine is mounted at the rear end of the locomotive.

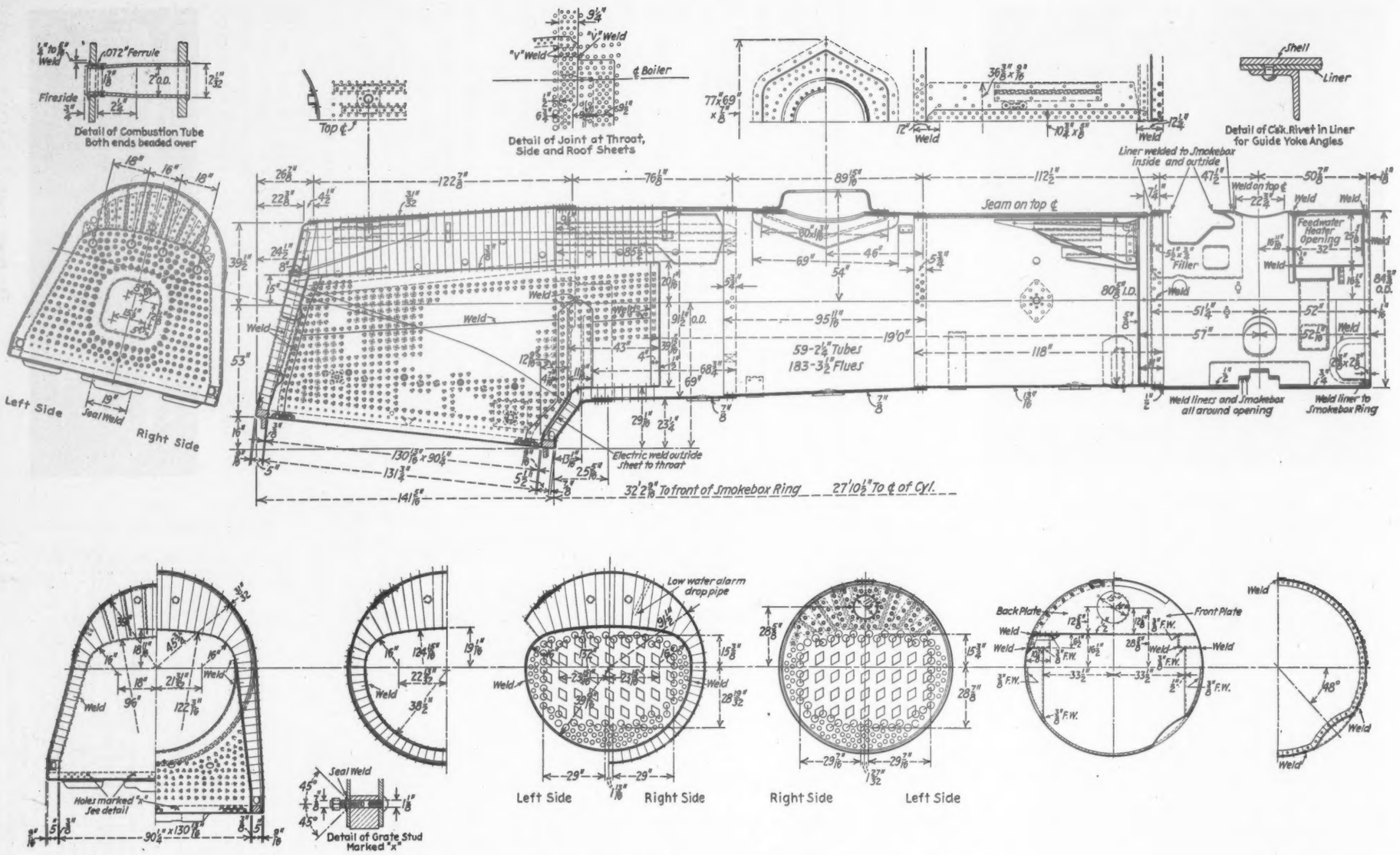
The locomotive is equipped with the Elesco type K40 feedwater heater which is mounted within the top of the smokebox in front of the stack. Recesses within the smokebox shell are provided for feedwater-heater pipe connections. The spark arrester is of the box type enclosed with Draftac netting on the top and sides and with a solid bottom at the elevation of the top of the exhaust nozzle.

There are steam separators on the dry pipes on these locomotives, those on half of the locomotives being the Tangential type and those on the other half being of the Dri-Steam type. Barco low-water alarms are fitted on all of the boilers. The American multiple throttle is built into the superheater header.

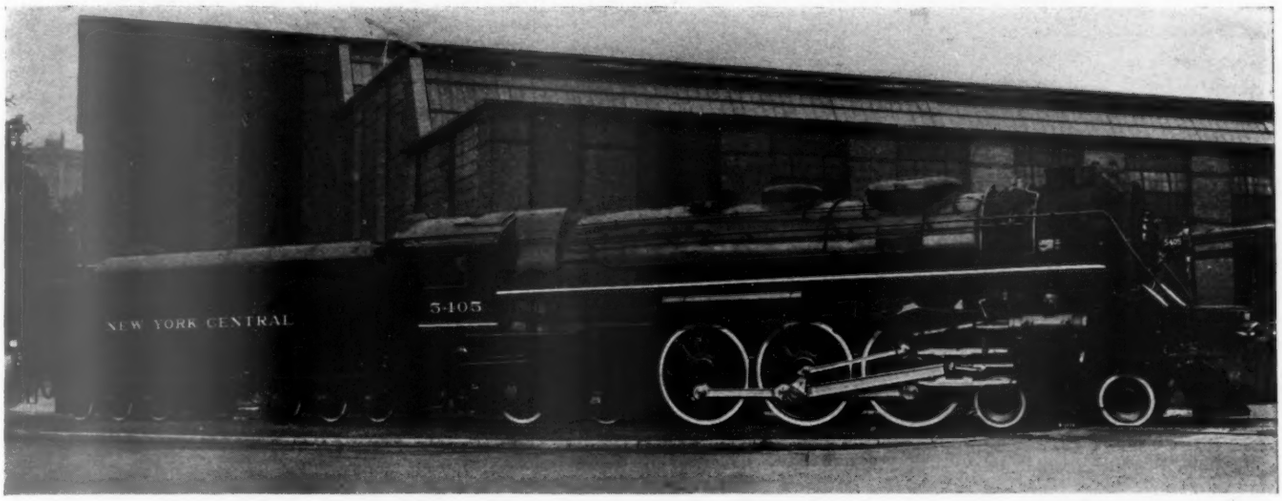
Engine Bed and Running Gear

The foundation of the locomotive is the General Steel Castings engine bed. Cast integral with the bed are the cylinders and back cylinder heads, the brackets for the air compressors, the guide yoke, the valve-gear-frame cross-tie, pads for the driver-brake cylinders and reverse

The tender truck



Cross-sections and elevation of the boiler of the New York Central Class J-3a 4-6-4 Type Locomotives



gear, and attachments for the stoker engine and cab brackets. The front bumper beam and the pilot are separate steel castings. The pilot includes a pocket for the counterbalanced disappearing coupler.

The boiler is supported by sliding shoes at the front corners of the mud ring and by expansion plates below the back head. Waist sheets are located at the guide yoke, at the valve-motion support, and between the second and third pairs of drivers. The main reservoirs are of Cor-Ten steel and are mounted in Economy combination reservoir and pipe brackets, supported from the boiler. The running boards are supported on separate brackets attached directly to the boiler shell.

The driving wheels are of the General Steel Castings Boxpok type on 25 locomotives and the Scullin disc type on the remaining 25. They are mounted on normalized carbon-vanadium steel axles, hollow-bored to 3½ in. diameter. The driving-journal bearings are fitted with Timken roller bearings in single-piece housings. The pedestal faces in the bed casting are parallel and are provided with cast-steel shoes faced with rolled-bronze liners welded in place. The pedestal caps are of alloy steel. The driving springs have reverse camber with conventional equalization.

The four-wheel engine trucks are of the Commonwealth equalized type with inside journal bearings. The truck frame is of special design to permit the carrying of the brake cylinder under the bolster in a sleeve which is an integral part of the frame. The Timken roller bearings are mounted in one-piece housings.

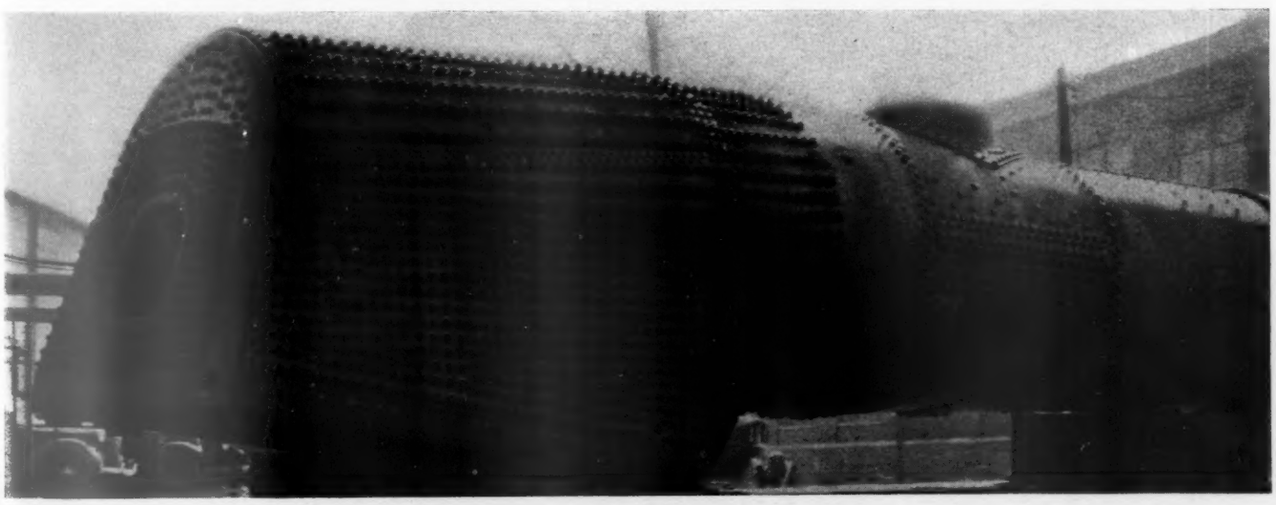
The trailer trucks are of the Commonwealth four-wheel type with outside journals which are fitted with Timken roller-bearing boxes. The Timken lateral-motion device is applied on the front trailer boxes. A Franklin C-2 type booster is installed on the trailer, the exhaust from which is discharged through the tank to the atmosphere.

The engine truck and front trailer wheels are rolled steel, while the rear trailer wheels have steel-tired cast-steel centers. Engine-truck axles are normalized carbon-vanadium steel, while the trailing truck axles are carbon steel. The rear trailer axle and engine-truck axles are hollow bored. All Timken bearings are equipped with automatic heat indicators. All pin bearings in the engine and trailer trucks, as well as in the spring rigging, are fitted with Ex-Cell-O steel bushings.

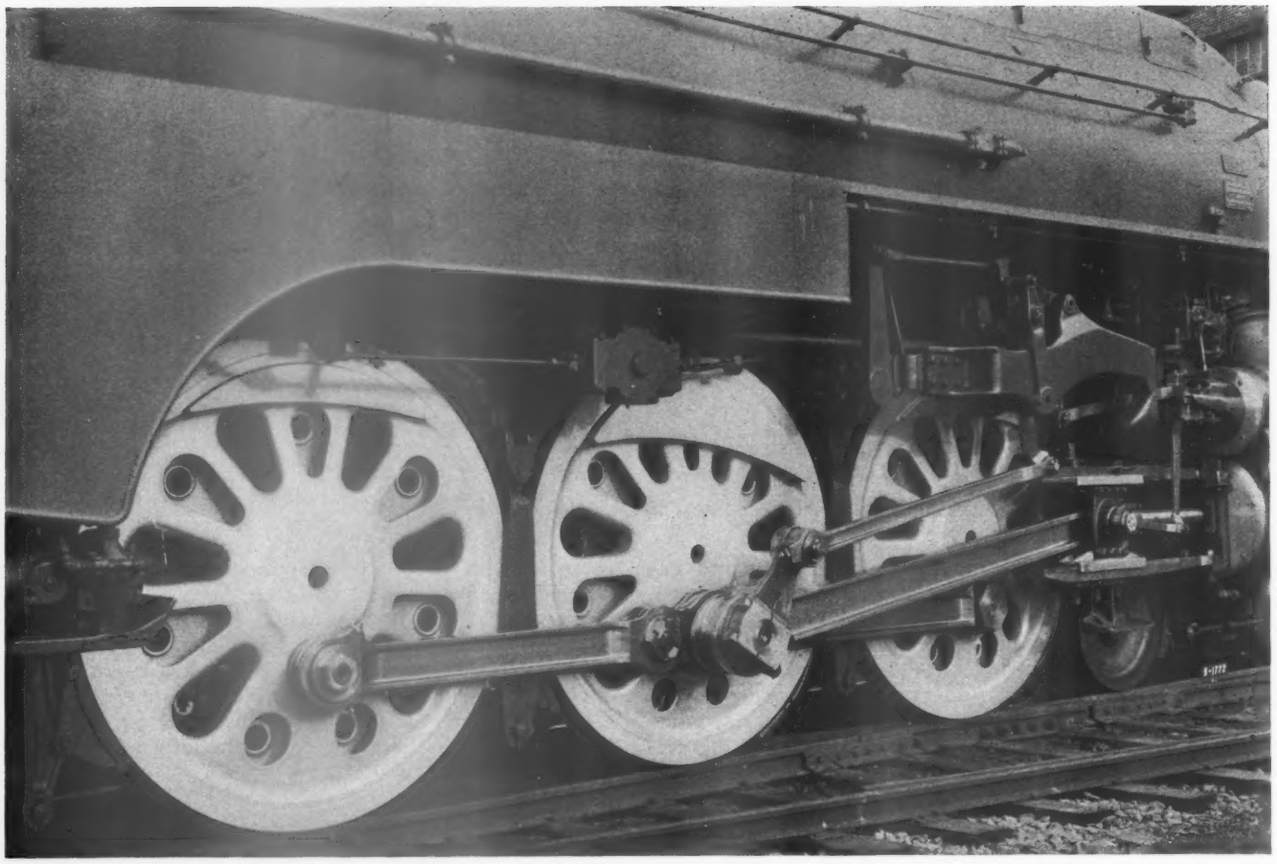
Driving Gear and Motion Work

The rods and crank pins on 45 of the locomotives are conventional. On five of the streamline locomotives are complete installations of Timken roller-bearing rods and crank pins. On all of the locomotives, however, the pistons, piston rods, and crossheads, including the wrist pins, are of Timken design and special alloy steel.

By the use of these parts the total weight of reciprocating parts on each side of the locomotive has been



The boiler of the New York Central J-3a locomotive



The running gear of the locomotives equipped with plain-bearing rods and Boxpok driving wheels

reduced to 1,000 lb. and the dynamic augment decreased by about 50 per cent of that of the J-1 class. With an overbalance of 134 lb. in the front and back driving wheels and 100 lb. in the main driving wheels the calculated dynamic augment at 90 m.p.h. is 8,100 lb. in each of the front and back wheels and 6,020 lb. in each of the main wheels. The revolving weights are cross-counterbalanced in all wheels.

The guides are of the two-bar type with the Slid-Guide floating connection of the top guide at the cylinder head. The Timken-two-piece crosshead, with a draw fit on tapered circumferential shoulders of the piston rod, has forged shoes of aluminum alloy. The crosshead contains a roller-bearing wrist-pin assembly.

Main driving wheels of the locomotives with conventional rods

The main and side rods on 45 locomotives are of nickel steel. In the back end of the main rod and side-rod middle connection are three-piece bronze floating bushings with fixed bushings of Hunt-Spiller gun iron. The front and back side-rod bearings are bronze bushings, pressed in.

On the 45 locomotives with plain crank-pin bearings the main crank pins are of normalized carbon-vanadium steel and the front and back crank pins are normalized and drawn carbon steel. The main pins are hollow bored to a diameter of 4 in.; the others, to 2½ in.

The cylinders and valve chambers are bushed with Hunt-Spiller gun iron. The pistons are fitted with L. F. M. bronze lip and ring cylinder packing, while the valves have Hunt-Spiller gun-iron bull rings and snap packing rings. King type rod packing is applied on piston rods and valve stems.

All of the locomotives have Baker valve gears and Loco Valve Pilots. On the five streamline locomotives on which the Timken roller-bearing rods are installed Multirol needle bearings have also been applied in the valve motion.

The Franklin Precision type reverse gear is mounted on the engine bed on the longitudinal center line of the locomotive. By the use of spiral gear boxes and universal and spline slip joints the operating shaft is carried from the cab along the side of the firebox to the reverse-gear cylinder under the boiler with complete flexibility of adjustment to changing length due to the expansion and contraction of the boiler. The boiler mounting of the reverse-gear cylinder is particularly difficult to maintain satisfactorily because of the constantly changing thrust reactions to which the boiler studs are

subjected when the locomotive is in service. The engine bed provides a better anchorage and relieves the boiler of these stresses. Furthermore, the location of the reverse gear on the longitudinal center line of the locomotive, so that the connection to the reverse shaft is at a point midway between the two valve gears, equalizes any distortion of valve events which may be caused by torsional strains in the shaft.

Main driving wheels of the locomotives fitted with Timken roller-bearing rods

Lubrication

A force-feed lubricator is installed on each of the locomotives. Four feeds lead to the cylinders and valves, two to the guides, one to the air compressors and one to the stoker engine. The Nathan Type DV 24-pint lubricator is on half of the order and the Detroit 32-pint lubricator on the other half. The Nathan atomizers are used on all of the locomotives.

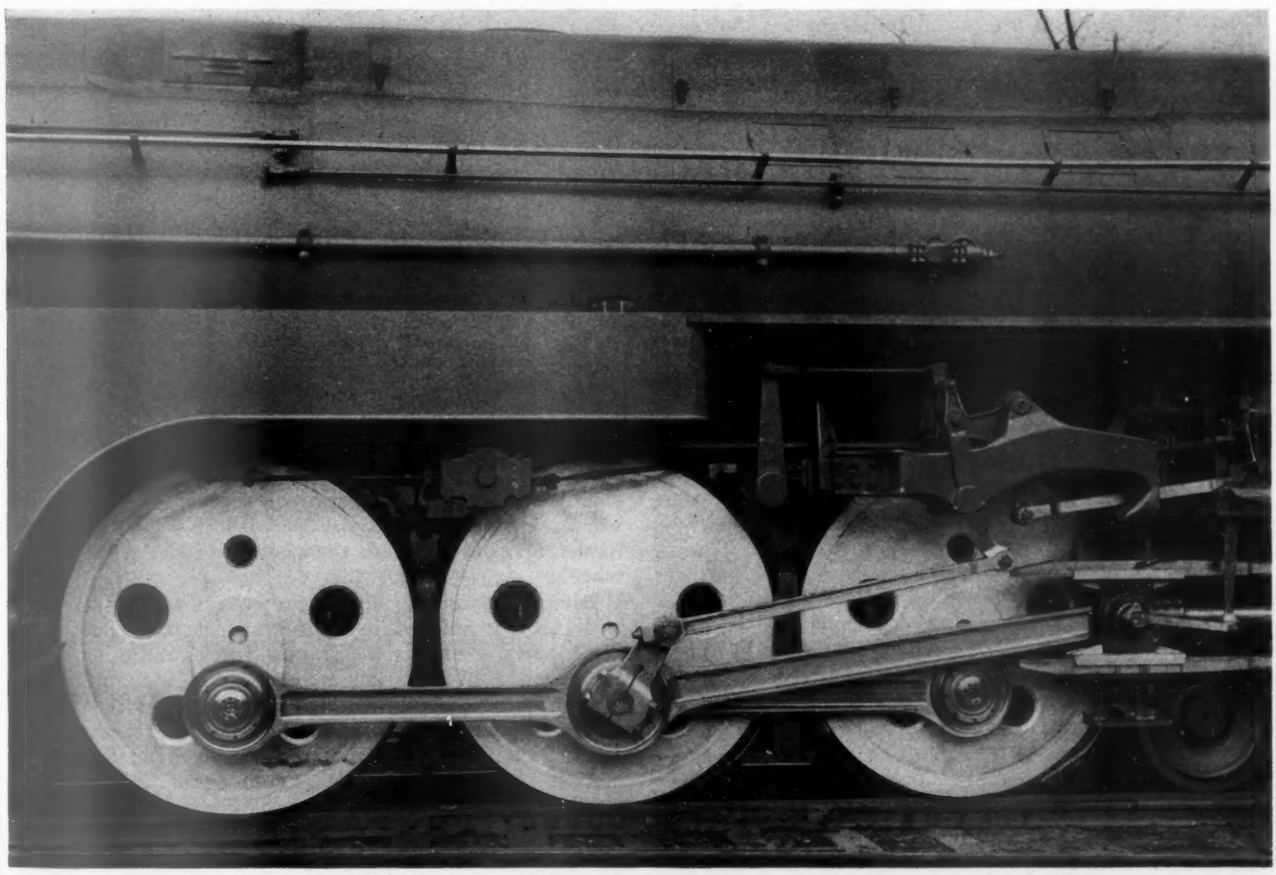
Alemite soft grease fittings are extensively applied. They are used on the valve gear, on the radial buffer, on the reverse gear, on the main and side rods, on the valve-stem crossheads, on the trailer spring-hanger pins, on the water-scoop piston rod, and on such auxiliaries as the Elesco feedwater pump and the speed recorder connections.

Rexoil fittings are installed for engine-truck-box, driving-box and trailer-truck-box pedestal lubrication and for roller-bearing wrist-pin lubrication. They are also applied on the roller-bearing rods.

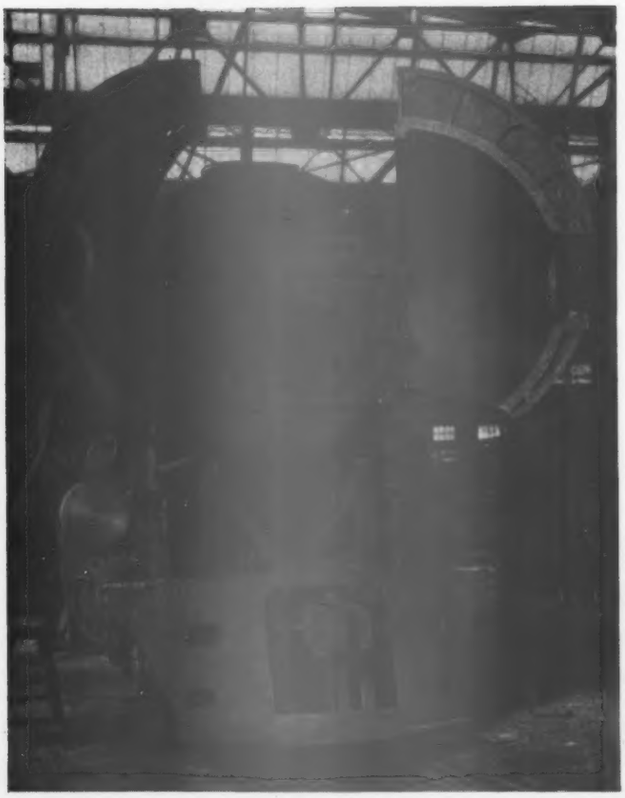
On all of the locomotives equipped with plain-bearing rods and crank pins there are air connections for use with a portable pneumatic grease gun with which the rods are lubricated.

The Cab

Aluminum alloy has been used extensively on these locomotives. The cabs and running boards of all but 10 of the non-streamline locomotives were built of this material, while Cor-Ten steel was used in the construction of the cabs and running boards of the remaining locomotives. The cabs and running boards of the 10 streamline locomotives are also of aluminum alloy, as are the cylinder and valve-chamber casings on all loco-



The running gear of the locomotives equipped with Timken roller-bearing side rods and Scullin disc-type driving wheels



The streamline nose is divided and hinged to facilitate access to the smokebox

tives. The hand rails are of aluminum pipe. Aluminum is also used for dome casing, safety-valve and steam-turret casings, and cab gage board. Laminated type safety glass is used in the cab windows and windshields.

The No. 8ET brake equipment was furnished by the New York Air Brake Company. The brake is modified to include the electro-pneumatic and speed-governor control for use with cars equipped with the H. S. C. type brakes. The brake valve is pedestal mounted.

Brake shoes are applied on the engine truck and the rear pair of trailer wheels as well as on the drivers. The braking ratio on the drivers and engine truck is 60 per cent and on the trailer 45 per cent.

The locomotives are fitted with the General Railway Signal train control. Graham-White sanders are applied. The sand capacity is 27 cu. ft.

The Tender

The tender tank is built up on a Commonwealth water-bottom cast-steel underframe. The water capacity is 14,000 gallons and the large coal space carries 30 tons. The tenders are fitted with water scoops and coal pushers are installed.

The tender trucks are of the Commonwealth six-wheel type with rolled-steel wheels. The tender axles are fitted with SKF roller-bearing boxes. Clasp brakes are applied on the trucks, with body-mounted cylinders.

All air and steam lines have Barco flexible connections between the engine and tender. The Vapor flexible metallic steam-heat connection is applied at the rear end of the tender. The tender drawbar is equipped with the Waugh rubber draft gear. The streamline locomotive tenders are equipped with A. A. R. tight lock couplers, furnished by the National Malleable and Steel Castings Company.

The Streamline Locomotives

The streamline locomotives are finished to the design of Henry Dreyfuss, offer relatively little interference to access to running gear and motion work, and weigh only 5,500 lb. more than the conventional design. The streamlining consists of the lagging and jacketing of the smokebox with a bullet nose type of covering over the front end and a housing over the top of the boiler extending forward from the cab to include the smoke stack, with air openings at the front for smoke-lifting purposes. The headlight is located at the middle of an aluminum crest which follows the contour of the bullet nose along the vertical center line of the locomotive from the housing which covers the top of the boiler to the shrouding which covers the space under the smokebox. This shrouding also covers the pilot. At the sides it extends only as far as the steps from the bumper beam to the running board. Below the running board, beginning at a point approximately half way back, is an apron which con-

Hinged hatches partially covering the coal space on the streamline locomotives are operated from the front of the tender

forms roughly to the line of the throat and mud ring and extends back to the rear of the cab.

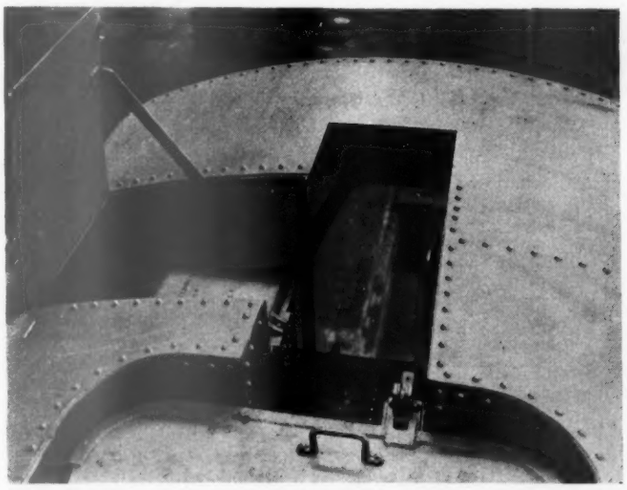
A housing which covers the sides of the tender coal space conforms to the curve of the cab roof. An inwardly curving skirt is dropped below each side of the tender approximately to the centers of the tender-truck wheels.

Above the running boards the boiler jacket, shrouding and cab are finished in light gray Duco. The underneath parts, including the frames, trucks and other parts, are finished in a darker tone of gray with aluminum finish on the driving wheels. The front cylinder head and valve-chamber casings are in the natural aluminum color. The main and side rods, as well as the valve-motion rods, are polished. Lettering and the striping on the tender are in aluminum. There are two longitudinal stripes in blue on the sides of the tender, one above and one below the aluminum striping and lettering. The background of the emblem on the front shrouding is also in blue.

There are relatively few changes in the location of equipment about the locomotive as a result of the streamlining. The Pyle-National turbo generator has been moved from the top of the boiler to a bracket on the engine bed just ahead of the trailer truck on the right side, opposite the location of the feedwater pump. The bell has also been removed from the top of the boiler and placed under the pilot.

Test Performance

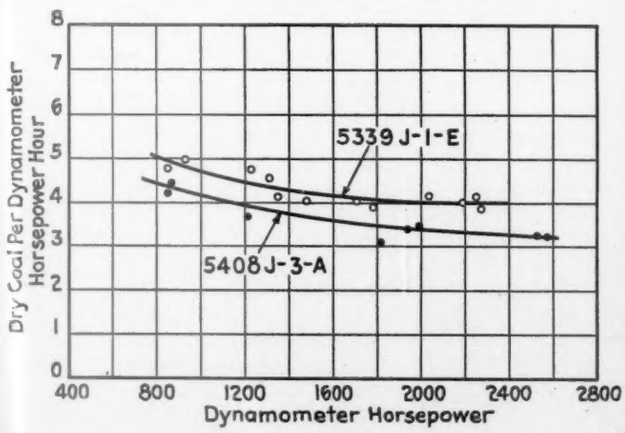
In dynamometer tests the new J-3a locomotives have developed a boiler capacity approximately 10 per cent greater than that of the J-1 locomotives, with an accompanying increase in boiler efficiency of about the same value. They have developed a maximum indicated horsepower of 4,700 at 80 m. p. h. and a maximum drawbar horsepower of 3,880 at 65 m. p. h. The J-1 locomotives in a number of tests developed a maximum indicated horsepower of 3,950 at 65 m. p. h. and a maximum drawbar horsepower of 3,200 at 57½ m. p. h. This is an



Hatchway leading from the rear of the tank to the filling-hole cover on the streamline locomotives—The trap door opens over the train-control equipment

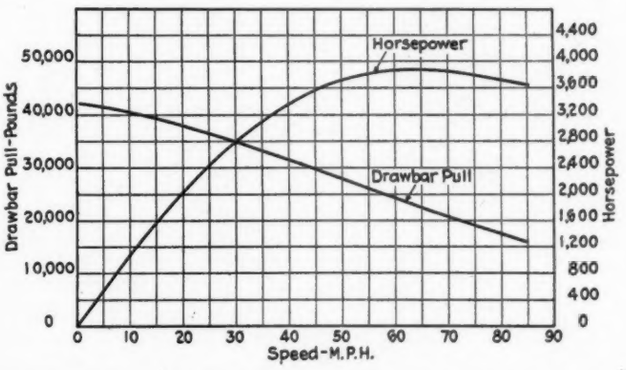
increase in drawbar capacity of the J-3 over the J-1 of 21 per cent.

At medium-capacity performance, burning 5,500 lb. of dry coal, tests of the new locomotive show an equivalent evaporation of 63,000 lb. per hour which compares with an equivalent evaporation of 57,500 for the J-1 locomotives at the same coal rate. This is an increase



A comparison of the dry coal per dynamometer horsepower-hour of the J-1e and J-3a classes of the New York Central

from an equivalent evaporation of 10.5 lb. per pound of dry coal to 11.5 lb. per pound of dry coal, or 9.6 per cent. At the high combustion rate of 8,250 lb. of dry coal per hour the new locomotives produce an equivalent evaporation of 89,000 lb. as compared with 81,000 lb. for the earlier class. This is an increase in equiva-



Drawbar pull and drawbar horsepower characteristics of the J-3a class 4-6-4 type locomotives

lent evaporation per pound of dry coal from 9.9 to 10.8, or 9.1 per cent. Although the boilers of the new locomotives have less superheating surface than those of the earlier class, largely because of the shorter tubes, they consistently show 30 and 40 deg. F. higher superheat at medium and high rates of boiler output, respectively.

In the range of average dynamometer horsepower (from 2,000 to 2,300) the new locomotives develop a drawbar horsepower with from 3.4 lb. of dry coal at 2,000 hp. to 3.25 lb. of dry coal at 2,300 hp. The locomotives of the earlier design showed approximately a flat dry coal rate of 4 lb. throughout this horsepower range.

Rear of the streamline tender

Service Failures

By Fred H. Williams, M. Sc., F. R. S. A.

FOLLOWING the several articles on failures of locomotive parts, it may be profitable to check up on other types of equipment and study some of the smaller parts which frequently fail in service. We are all familiar with the old hand car which was modernized and equipped with a gasoline motor, the drive being through a crank shaft. Photographs of one of these broken shafts are shown in Fig. 1. The view at the left gives a good idea of the design of the shaft and the location of the fracture. The other end of the shaft, showing the section through the break, is at the right, an enlarged view of this break being shown in Fig. 2.

The nucleus of the fatigue crack is at the surface, on the inside of the crank arm, and is just at the root of a sharp corner, where the face of the arm was machined off for clearance. The photograph does not bring out this detail as clearly as it should and the small sketch has been added to give a better conception of the actual condition. Instead of leaving a nice fillet, the tool cut a square corner, and not too smoothly at that. The machinist, apparently thinking that the corner was about ⅜ in. from the real fillet—and being on the side—it did not matter whether a fillet or a square corner was made. The result was that the shaft not only cracked, but actually broke in service. Obviously it does not require a great amount of expense to replace such a shaft, but a failure in service involves the possibility of the workers on the car being stranded at some out-of-the-way place, involving all sorts of inconveniences and possible expense.

As in the case of the failures of locomotive parts which we have studied, the surfaces were subjected to alternating or reversible stresses. The first breakages of these crank shafts occurred when the fillet between the pin and the arm was quite sharp. This was remedied, but unfortunately, in taking another cut to provide proper clearance for the arm, a sharp corner was left—and with disastrous results. It should be emphasized, also, that the fillets should be smooth and polished and be entirely free of score marks and tool marks.

A more recent model of one of these crank shafts which failed, is illustrated in Fig. 3. The side view shows the shape of the shaft and the location of the fracture; below it are views showing the fractured surfaces. Fig. 4, an enlargement of the surface of the machined section alongside the break, indicates clearly that the fracture followed lines left by rough machining of the fillet. This may have been due to speed in production, or to carelessness, or to a lack of appreciation of the importance of using great care in machining and finishing such surfaces. While it may be argued that the crank shaft on a remodeled hand car is not of very great importance, one can readily conceive of instances when a disabled hand car, at a critical time, may be of greatest importance. In railroad operation the strength of a chain is only as great as its weakest link.

Change in Diameter of the Shaft

A broken armature shaft of a car lighting generator which failed in service is shown in Fig. 5. One would think that only the best of materials and finishes, as well as the best design would be used for such services. This part, however, failed because of a square cut corner with no fillet when a reduction in section was made.

The extent of this may be judged by comparing the two broken parts in Fig. 5, or by referring to the cross section of the break shown in Fig. 6. The shaft broke in the sharp corner and there was the usual progressive crack, which we have come to know as a fatigue crack.

Frequently it is stated that a failure is caused by a flaw in the steel, whereas the real cause is a fatigue crack which developed progressively, until a blow or shock was greater than the remaining strength of the section and the part failed suddenly. It is true that there are cases where failures have been caused by impurities or defects in the steel, which caused fatigue cracks to start. Generally, in these cases, however, the crack starts within the section and not from the surface.

Fig. 1—Two photographic views showing fractured crank shaft of motor car. (The small sketch between these two views illustrates the conditions more clearly.) Fig. 2—Enlarged view of fracture of the crank shaft shown in Fig. 1. Fig. 3—Crank shaft that failed in service because of rough machining. Lower view shows fractured faces. Fig. 4—Enlarged view showing finish on the side of the crank arm (Fig. 3) which was machined for clearance. Fig. 5—Broken parts of car lighting generator armature shaft. Fig. 6—Enlarged view of fractured end of armature shaft shown in Fig. 5

The two parts in Fig. 5 are so placed in the photograph that the fractured ends are at the right, the fracture taking place where the sharp reduction in the section of the shaft occurred. It is quite apparent from the cross section in Fig. 6 that an attempt was made to form a fillet, but it was so small as to be useless and the machining was also quite rough. The frilled edges of the fracture indicate that the cause of the failure was tears in the surface of the metal. Many small cracks started, eventually joining up and making one well marked fatigue crack, which caused the failure. This type of failure is not infrequent and until the manufacturers and the railways realize the consequences of inadequate fillets and rough finish, failures will continue to occur, to the loss of the railways and the inconvenience of the traveling public.

A curious thing happened in attempting to improve conditions. A new lot of armature shafts was applied with fillets of generous proportions. The finish of the surface of the fillet, however, was filled with fine score marks, left by the use of emery cloth and a stick or some other instrument of torture. Closer examination showed that one mark was deeper than the rest. Questioning the man regarding the assembly and watching him put the parts together to replace in stock, I noticed that the lock washer was removed to reverse it in order to clamp the assembly. Examining this washer, I found that it was a cut washer, pressed concave or dished. When the assembled parts were held tightly by this dished washer, wrongly put in place, the sharp edge

(*Continued on page 181*)

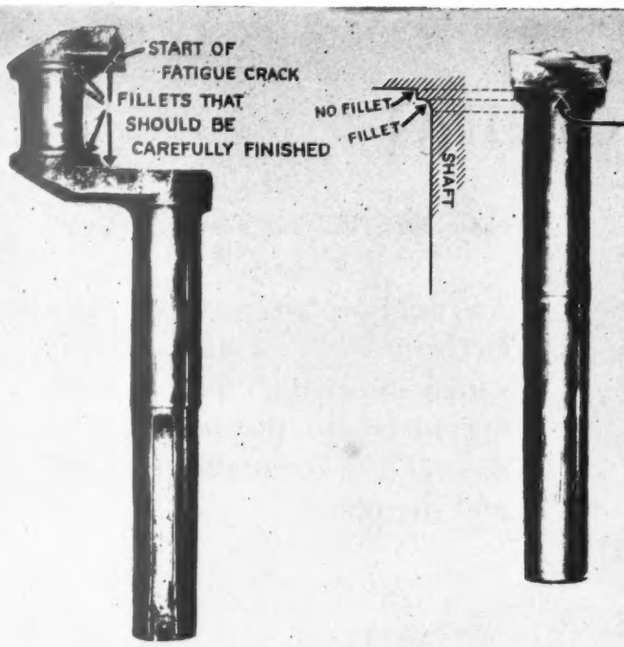


FIG. 1

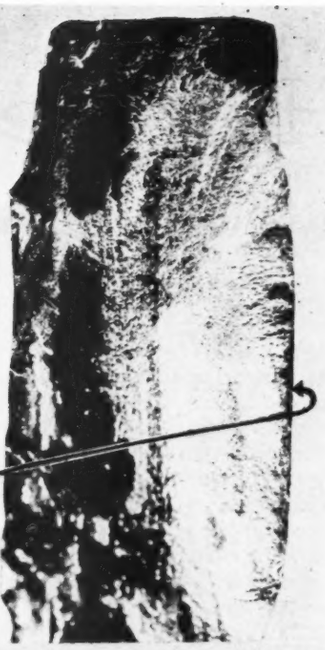


FIG. 2

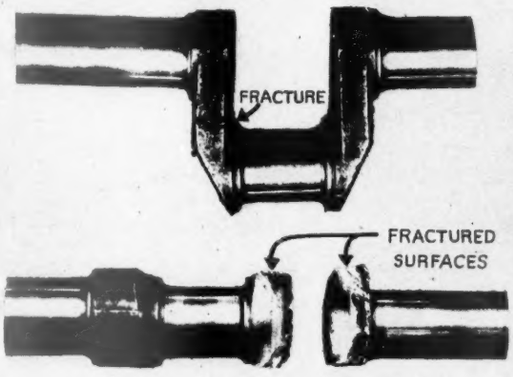


FIG. 3

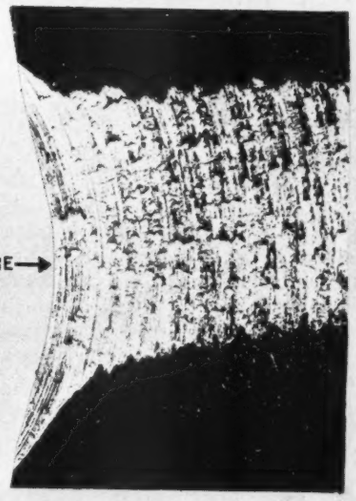


FIG. 4

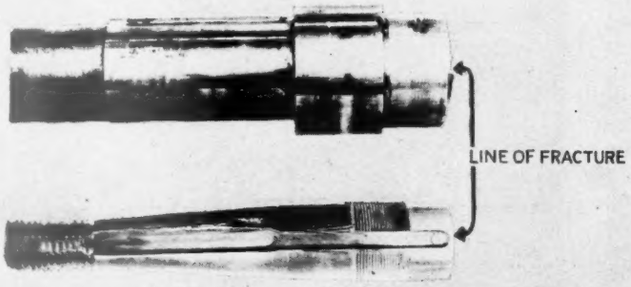


FIG. 5

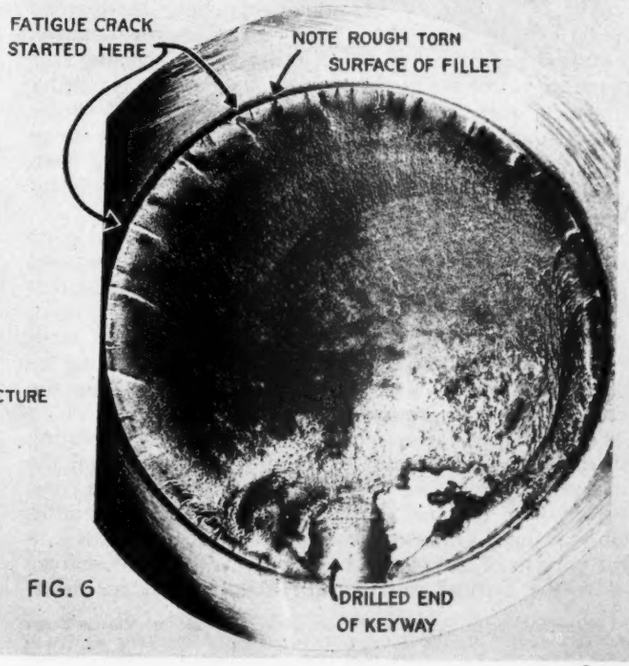


FIG. 6

An Analysis of

Heat Effect in Welding*

By Dr. W. G. Theisinger†

An analysis of welded plain carbon and low-alloy steels which shows the effect of welding speed on the hardness of the weld, the heat-affected zone, and the plate

THE commercial interest in the heat effect produced by welding is centered about the hardening in the metal adjacent to the weld, sometimes resulting in cracks in the parent steel. Regardless of whether or not failure to the point of rupture occurs near the weld, hardening in this region should be kept to a minimum in order to avoid the danger and cost of shop cracks and the inability to absorb impact in service, otherwise encountered through an area of unequal physical properties.

In order to study the cause and the development of these effects, it is necessary to consider the several functions of the welding process itself. These various operations produce results to a degree depending upon the value of each element, such as current and its time of application, mass and condition of the material being welded and, most important, the chemical composition of the material.

Welding makes use of the melting, casting, solidification and subsequent heat-treatment of metals in its application to fabrication processes. The electric arc or the oxy-acetylene flame heats the metal surfaces to the molten state and casts this liquid by the movement of the heating instrument. Solidification of the deposited metal results from its loss of heat by radiation into the surrounding atmosphere and by the conduction of its heat into the adjacent base metal. Heat treatment manifests itself in the parent member by virtue of this heating effect created by the fused metal and the heating medium. Even though the procedure employed by welding in transforming a solid metal to the fluid state and back again to solid form in the space of a few seconds or fraction of a second takes place more rapidly than is customary in heat-treating practices, the mechanics of the physical changes are, as a matter of fact, metallurgical in nature.

The heat-affected zone found in welded sections is due to the property possessed by iron, containing a sufficient amount of carbon, of becoming extremely hard when rapidly cooled from a high temperature, as for instance, by quenching in water from a bright red heat. This operation is known as the hardening of steel. In order to harden steel, it is necessary first to heat it above its critical range because it is in passing through that range that it acquires hardening power. Sudden cooling from a temperature inferior to its critical range would result in but a very slight, if any, increase in hardness.

The requirements for hardening the parent steel plate in the heat-affected zone adjacent to a weld are satisfied in every detail. The steels studied in this investigation contain not less than 0.15 per cent carbon so that rapid quenching would produce a measureable increase in hardness. Rapid quenching is brought about in welding by the mass action of the parent metal in conducting the heat rapidly away from the vicinity of the weld.

Temperatures far exceeding the normal heat-treating critical range are reached in melting the metal, and the amount of steel melted in making a weld is small in comparison with the size of the parent member. In addition, the heat gradient is steep from the fused area to that portion of the plate which remains at a temperature below the critical range. For this reason, the heat-affected or hardened zone is usually limited to a fraction of an inch in depth beyond the weld.

Thus the heat-affected zone is found in any process which produces a weld. Its depth and hardness depend upon the variables present. It is apparent that this zone of unequal hardness which disrupts the continuity of the physical properties should be eliminated or at least kept to a minimum.

The heat effect becomes visible on a cross section of

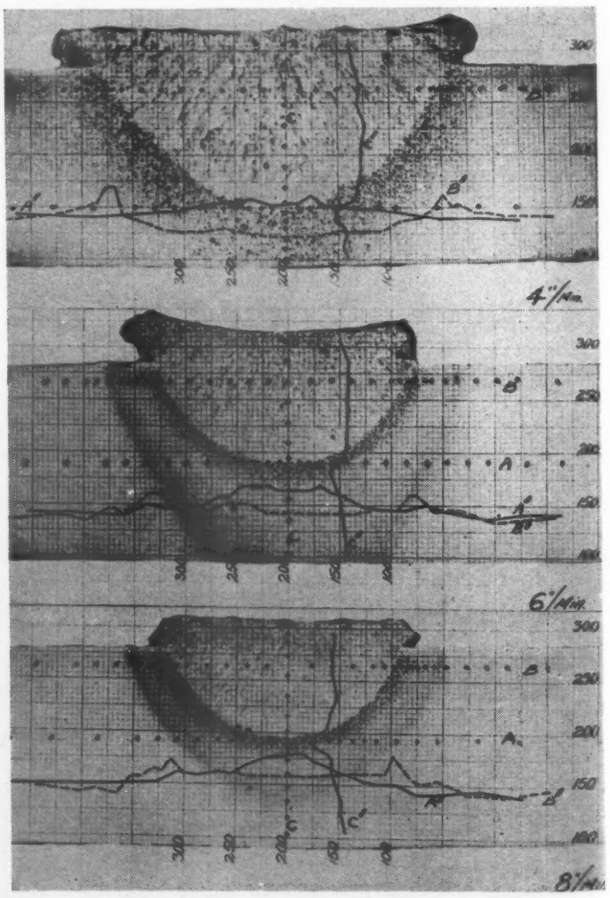


Fig. 1—S. A. E. 1035 steel (0.33 per cent carbon) x 4. Top: Hard zone = Vickers-Brinell using a welding speed of 4 in. per min.—Center: Hard zone = 168 Vickers-Brinell, using a welding speed of 6 in. per min.—Bottom: Hard zone = 177 Vickers-Brinell, using a welding speed of 8 in. per min.

* Presented at the twenty-fourth annual meeting of the Master Boiler Makers' Association, held at Chicago, September 28-30, 1937.

† Welding and Metallurgical Engineer, Lukens Steel Company, Coatesville, Pa.

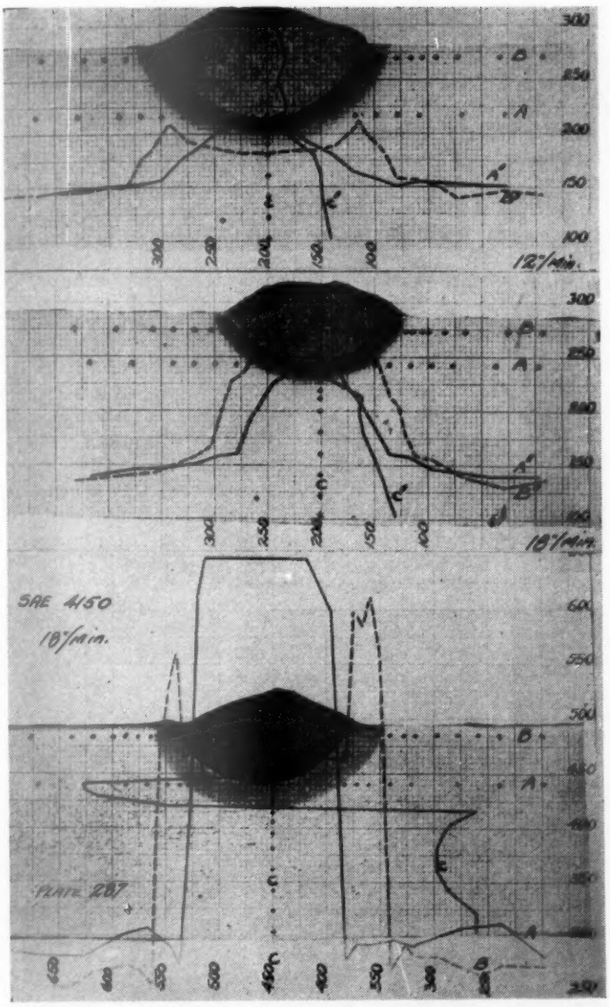


Fig. 2—Top: S. A. E. 1035 steel (0.33 per cent carbon) x 4. Hard zone = 212 Vickers-Brinell, using a welding speed of 12 in. per min. Center—S. A. E. 1035 steel x 4. Hard zone = 250 Vickers-Brinell, using a welding speed of 18 in. per min.—Bottom: S. A. E. 4150 steel (0.52 per cent carbon, Cr — Mo) x 4. Hard zone = 642 Vickers-Brinell, using a welding speed of 18 in. per min.

the welded specimen after suitable etching of the polished surface. It appears as a zone of varying shades of color grading from black to light gray in the plate material at the rim of that portion of the weld which is in contact with the parent member.

It has been pointed out that the welding process brings about the conditions which cause the hardening in the heat-affected zone adjacent to the weld. This would imply that amperage is the greatest contributing factor, yet the heat energy input per unit of weld is of greater importance, thus introducing speed of welding as one of the main variables. The higher the welding speed, the more rapid is the quench and the greater is the hardness.

However, there are other variables outside the welding process itself which exert considerable influence. For example, all other conditions being equal, a thick plate will produce a greater hardness than a thin plate.

The most powerful variable affecting the hardness of the plate metal adjacent to a weld is the hardening power of the plate metal. The common method of raising the hardening power of ferrous metals is to increase their carbon content. Carbon increases the tensile strength, but it also augments the response of the steel to hardening operations. The low-alloy steels attain the higher physical values by the use of alloying elements other than carbon.

The variables of paramount importance which govern the extent of the heat affected zone in arc welding are (1) base-metal composition, (2) speed of welding, (3) heat-energy input, and (4) base-metal cross-section.

In this study, the welded specimens were prepared by depositing the "weld," or in more exact terms, a "bead" on the top surface of a series of steels ranging from 0.17

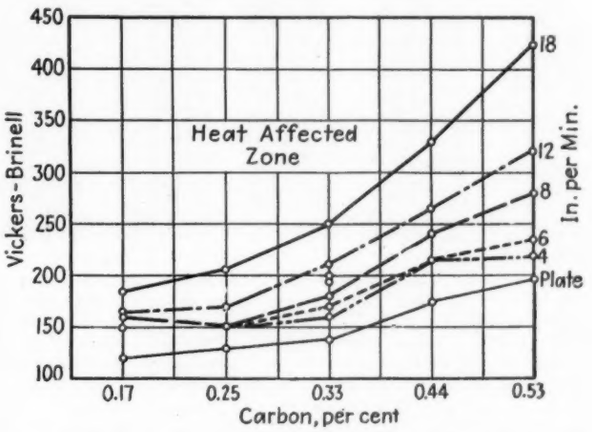


Fig. 3—Summary of hardness values on five plain carbon steels welded at varying speeds. The hardness of the unaffected plate is shown for comparison

to 0.53 per cent carbon, using an automatic welding machine and bare wire. With no alloying elements being added intentionally, these steels are classed as plain carbon steels. Vickers-Brinell hardness impressions were run across the weld, affected zones, and the plate metal beyond the weld, and photomicrographs were taken to reveal the structure in the affected region.

The hardest portion of the heat-affected zone is immediately adjacent to the weld, as may be seen by the accompanying illustrations, and the real measurable increase in hardness usually does not extend over ¼ in. beyond the weld into the plate. This is indicative of the steep temperature gradient, which exists in this area. As a matter of fact, in this confined zone, the temperature must range from 1,530 deg. C. (the melting point of steel) at the weld to 700 deg. C. at the outer edge of the heat zone, beyond which there is no change in microstructure. Hardness curves for an S. A. E. 1035 steel of 0.33 per cent carbon is shown in Figs. 1 and 2 for welding speeds of 4, 6, 8, 12 and 18 in. per min. The amperage and voltage values are held constant, and the plate dimensions of 9 in. × 2 in. × ½ in. are maintained throughout. The cross sections were taken at right angles to the direction of welding and were polished and etched to reveal the weld and the plate metal. The heat-affected zones appear in the base metal adjacent to the weld. The area of this zone decreases with increasing welding speed, but the hardness increases as the welding speed becomes greater. In other words, the slower welding speeds produce a greater spread of heat through the adjacent metal

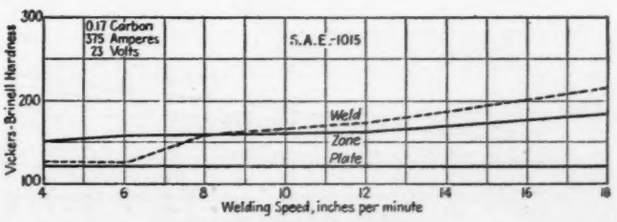


Fig. 4—Hardness curves for S. A. E. 1015 steel (0.17 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 18 in. per min.

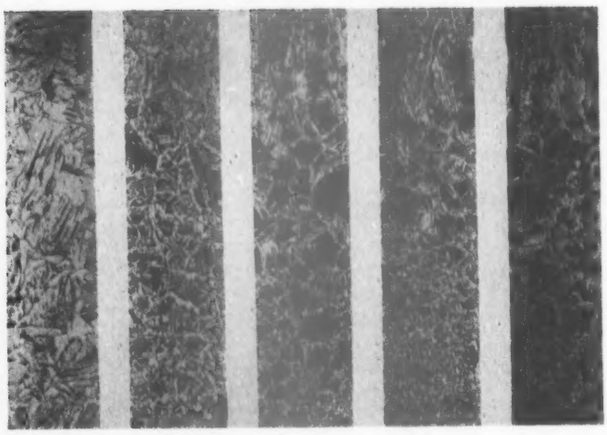


Fig. 5—S. A. E. 1015 steel (0.17 per cent carbon) etched with 1 per cent Nital x 150. Left to right these views show microstructures for welding speeds of 4, 6, 8, 12 and 18 in. per min. and show pearlite to sorbite with decreasing grain structure. Fine grain structure at the extreme top of each view is the weld area while the coarse grain structure is the plate area

and thus slows down the quenching rate action of the base metal on the heated region surrounding the weld.

Three lines of hardness impressions extend across the face of the specimen, one vertical and two horizontal lines. The hardness curves are superimposed on the macrographs of the welded specimens and may be referred to for the hardness of any particular point.

The solid curve *A'* indicates the hardness of the horizontal line *A* of impressions tangent to the base of the weld. The broken curve *B'* shows the hardness of the horizontal line *B* near the top of the specimen. The solid line *C'* follows the vertical *C* through the middle of the weld and heat zones. The extremes of the curves reveal the hardness of the unaffected base metal, although this actual determination was made near the sides of the specimen, beyond these views.

The peaks of the hardness curves coincide with the plate metal adjacent to the weld wherever a line of impressions crosses this area. These peaks become more pronounced naturally as the speed of welding is increased. The slower welding speeds result in a more uniform distribution of physical properties across the region.

Hardness curves are also shown in Fig. 2 for an alloy steel of 0.52 per cent carbon; the steel is S. A. E. 4150, and is included here as an example of an extremely high hardness that may be found in a steel of high hardening power welded at high speed. The microstructure in the plate metal adjacent to this weld is completely martensitic as is to be expected from a hardness of 642 Vickers-Brinell. After stress relieving at 1,150 to 1,200 deg. F. the hardness of this specimen was reduced to 370 Vickers-Brinell.

The hardness results obtained from the exploration of the plain carbon steels ranging from 0.17 to 0.53 per cent carbon are summarized in Fig. 3. The Vickers-Brinell

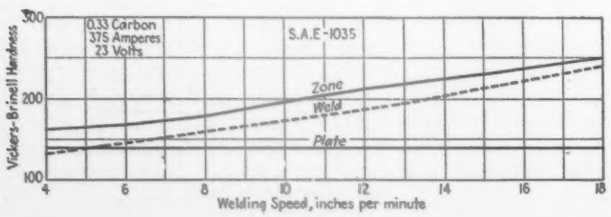


Fig. 6—Hardness curves for S. A. E. 1035 steel (0.33 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 16½ in. per min.

values are shown with carbon content and the curves are plotted for each welding speed. The lower-carbon steels may be welded at even the fastest rate without provoking objectionable hardening in the affected area, whereas the higher-carbon steels are not as foolproof and must be given more consideration in the selection of a welding speed. If a line were drawn at a random figure of 225 Brinell, then the 0.17 and 0.25 per cent carbon steels may be welded at 18 in. per min., the 0.33 per cent carbon steel at 12 in. per min., and the 0.44 and 0.53 per cent carbon steels limited to 6 in. per min. This simply points out that as the carbon content of the plate metal is increased, the welding speed should be decreased. Figs. 1, 2 and 3 are given in general terms to be considered as trends and not as specific requirements.

The significant fact suggested by Fig. 3 is the peculiar position occupied by the 0.33 per cent carbon specimen. As the carbon increases beyond this point, the curves rise rapidly for any welding speed, and the spread between the hardness of the affected zone and the unaffected plate becomes greater with the higher-carbon steels and the faster speeds. This is further evidence of

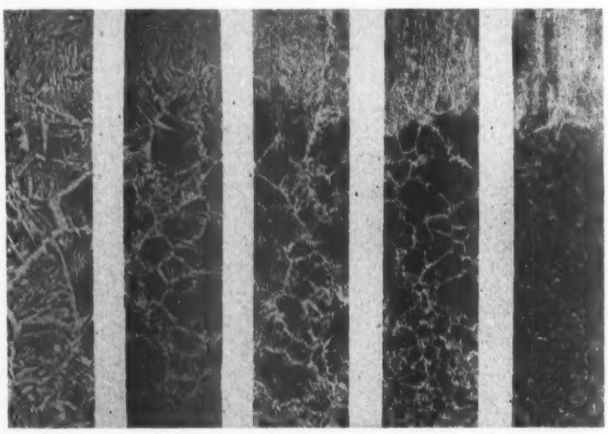


Fig. 7—S. A. E. 1035 steel (0.33 per cent carbon) etched with 1 per cent Nital x 150. Left to right these views show microstructures for welding speed of 4, 6, 8, 12 and 18 in. per min. and shows pearlite to sorbite with decreasing grain structure. Fine grain structure at the top of each view is the weld area while the coarse grain structure is the plate area

the hardening power which carbon imparts to steel and its susceptibility to any hardening operations. Up to 0.33 per cent carbon, the rise in hardness of the steel is gradual.

In Fig. 4, the hardness curve of S. A. E. 1015 (0.17 per cent carbon) steel is shown. The maximum variation from the unaffected plate is only 65 points Brinell, i.e., from 120 to 185 at 18 in. per minute. Such a steel may be welded in the medium gages without much concern for the heat-affected zone and the hardness resulting from the welding operation.

The microstructure of a portion of the weld and much of the heat-affected zone is shown in Fig. 5 for the five welding speeds corresponding to those given in Fig. 4. The large grain structure appearing in the 4-in. speed sample is to be expected from the slow cooling rate such a welding speed imparts to the steel. This structure is made up of pearlite and sorbite with decreasing grain size as the more rapid cooling rates are met with in the higher welding speeds.

An S. A. E. 1035 (0.33 per cent carbon) steel was selected from the group for illustration; the hardness curves of this steel are shown in Fig 6. This chart is a summary of the curves for S. A. E. 1035 steel appearing on the macrosections in Figs. 1 and 2. Only the maxi-

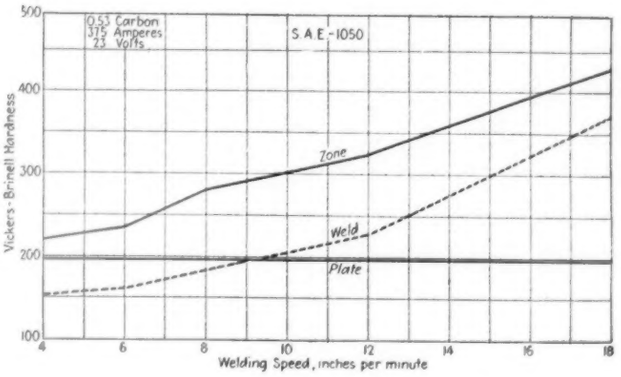


Fig. 8—Hardness curves for S. A. E. 1050 steel (0.53 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 9 in. per min.

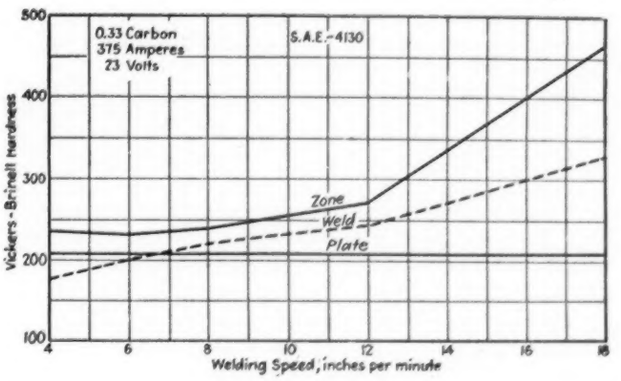


Fig. 10—Hardness curves for S. A. E. 4130 steel (0.33 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 13 in. per min.

mum hardness figures for each specimen are plotted on the curves in Fig. 6. For example, by referring to the top view in Fig. 2, which shows the complete curves for S. A. E. 1035 steel welded at a speed of 12 in. per min., the following values are obtained by tracing the three lines of impressions through the hardest area of the heat zone: Hard zone, 212 Vickers-Brinell; weld, 185 Vickers-Brinell, and plate, 137 Vickers-Brinell. These hardness figures are shown on Fig. 6 for this speed of 12 in. per min. The other points on these curves are obtained in the same manner.

Microscopic views of this steel are shown in Fig. 7. The structure ranges from large-grained pearlite at the slower welding speeds to fine-grained sorbite at the higher rates. The balancing of microstructure and hardness seems to take place at the 6-in. and 8-in. speeds. Large grain size, such as appears in the specimen welded at 4-in. per min., is not especially objectionable in plain

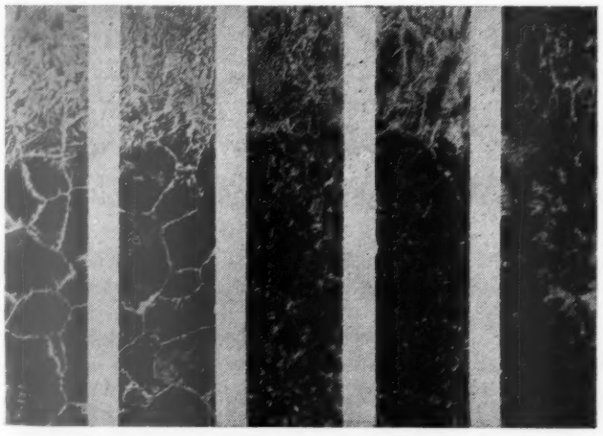


Fig. 9—S. A. E. 1050 steel (0.53 per cent carbon) etched with 1 per cent Nital x 150. Left to right these views show microstructures for welding speeds of 4, 6, 8, 12 and 18 in. per min. with sorbite to troosite, and sorbite to troostite with patches of martensite with decreasing grain structure. Fine grain structure at the top of each view is the weld area while the coarse grain structure is the plate area

carbon steels, only as it brings out a dissimilarity in the grain structure between the affected area and the rest of the plate. The characteristic columnar appearance of weld metal deposited with bare wire and not subjected to further heat treatment may be seen at the top of each illustration.

The hardness curves of the highest-carbon steel examined in this series of plain carbon steels is shown in Fig. 8. The rapid rise in hardness as the welding speed is increased is typical of high hardening power which 0.53 per cent carbon imparts to steel. In order to maintain a close relationship between the hardness of the heat-affected zone and the base metal, the slower welding speeds must be maintained. Fig. 8 shows that the hardness of the weld metal at the slower speeds drops below that of the plate. Such a condition is a result of the selection of one type of bare electrode wire for all steels in this entire series. This was done in order to keep constant the grade of welding wire for the steels and eliminate the wire as a variable in comparing the weld effect on the base metal only. After all, the problem had to do with the plate in this study and not with the deposited metal. However, it is reasonable to assume that with the use of a suitable high-strength rod, the weld hardness would, in general, keep pace with the hardness of the affected plate.

The photomicrographs in Fig. 9 indicate hardened steel at the higher welding speeds. The structure ranges from sorbite to troostite, and to troostite containing patches of martensite; the latter structure is shown in steel welded at 18 in. per min. Such a steel should be welded with caution wherever the welding of this steel is necessary.

Low-Alloy Steels

Welding brings about a drastic heat treatment in the plate steel adjacent to the weld to an extent depending upon the composition of the metal and the welding pro-

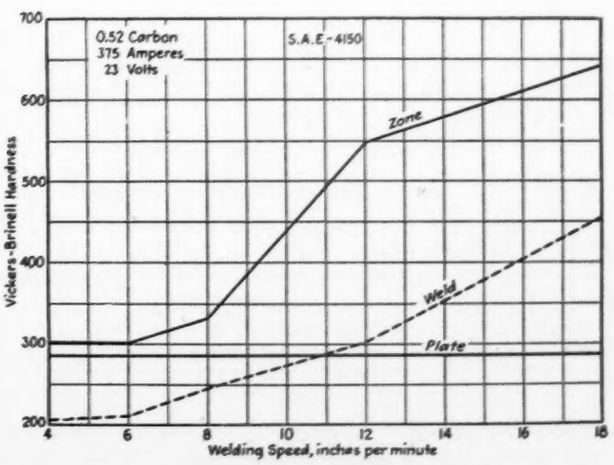


Fig. 11—Hardness curves for S. A. E. 4150 steel (0.52 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 8 in. per min.

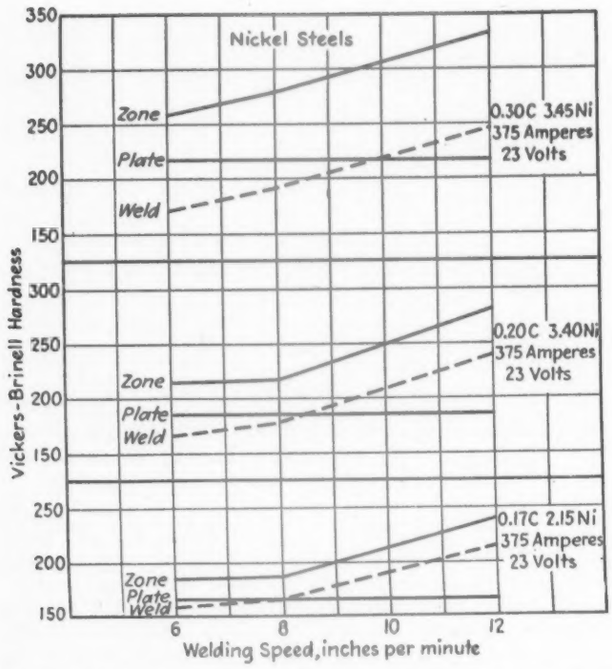


Fig. 12—Hardness curves for welding nickel steels, showing effect of different percentages of carbon and nickel

cedure used. Since most special steels respond readily to heat treatment, it seems reasonable to expect that the welding conditions should receive considerable attention in order to attain the minimum amount of hardening in the affected area.

A chromium-molybdenum steel with 0.33 per cent carbon (S. A. E. 4130) was welded by depositing beads as described for the plain carbon steels. The hardness values for the usual range of welding speeds is shown in Fig. 10. It should be noticed specially that the hardness curve for the hard zone is relatively flat up to the 12-in. speed.

In Fig. 11 the hardness of the same type of alloy steel is illustrated, but here the carbon content is 0.52 per cent (S. A. E. 4150). These curves show the effect of carbon to be more pronounced when joined together with alloying elements. The maximum hardness is 642 Vickers-Brinell and the allowable welding speeds are limited to the lower range. It is apparent that care should be taken in welding this steel in order to avoid shop or service cracks resulting from high hardness and unequal physical properties.

Stress relieving does reduce the hardness of such a weld-effect area, but stress relieving cannot heal cracks already formed in any steel whether they are produced by heat effect or any other cause.

The nickel-alloy steels have been investigated in this

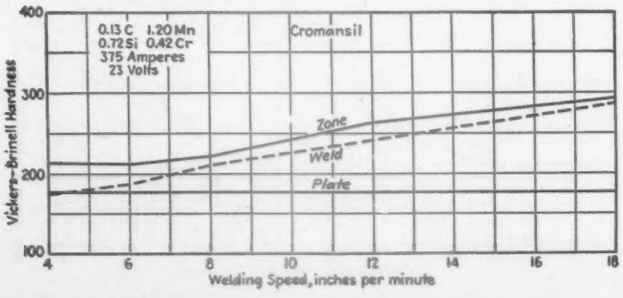


Fig. 13—Hardness curves for Cromansil steel. Maximum allowable welding speed based on 100 points Brinell = 15 in. per min.

study in view of their adoption by the A. S. T. M. The hardness curves in Fig. 12 illustrate the effect of carbon in combination with nickel in influencing the heat affected zone. Again low carbon is helpful as the hardness is decreased materially at any of the welding speeds shown. This is evident after an examination of the top and middle charts. With the same nickel content, the reduction in carbon from 0.30 to 0.20 per cent drops the curve substantially. The bottom chart shows that lowering the carbon still further and also decreasing the nickel, brings a closer relationship between the plate and the heat-affected zone.

Another alloy steel known to the trade as Cromansil steel is also included. The hardness curves are shown in Fig. 13. This is a low-carbon alloy steel, containing 0.13 per cent carbon with alloy additions of chromium, manganese and silicon. The slope of the hard-zone curve is gradual and the maximum variation between the 4-in.-per-min. and the 18-in.-per-min. speed is 75 points Vickers-Brinell. This steel lends itself readily to considerable latitude in the welding conditions. For tensile

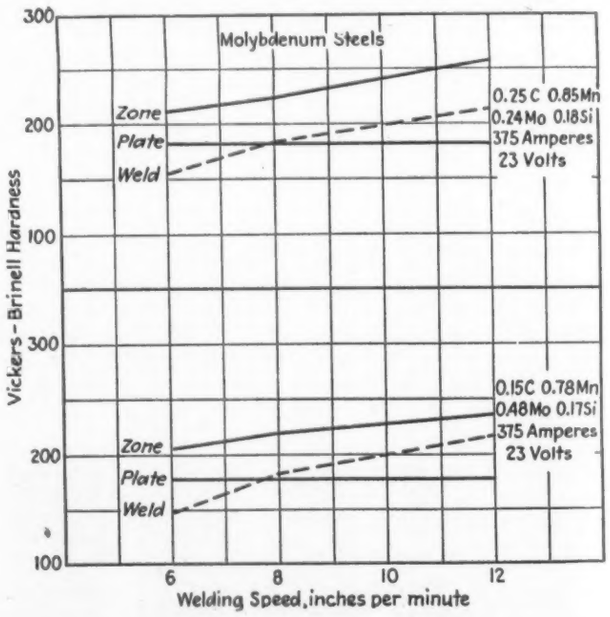


Fig. 14—Hardness curves for Molybdenum steels, showing the effect of decreasing carbon content and increasing the Molybdenum content

properties of 75,000 to 90,000 lb. per sq. in., such a steel combines strength without serious hardening in the weld-effect area.

Another alloy steel which has been approved recently by the A. S. T. M. is carbon-molybdenum steel. The Lukens Steel Company reports that this grade of steel, as made by them, has a tensile strength of around 80,000 lb. per sq. in. in the as-rolled condition and about 75,000 lb. per sq. in. after stress relieving. Carbon-molybdenum steel is used where high strength and ductility are required and where the hardening of the plate metal adjacent to the weld must be reduced to a minimum.

Fig. 14 shows the hardness curves of two analyses of this steel. The 0.15- to 0.25-per cent-carbon steel with 0.50 per cent molybdenum has been the most popular and best suited for welded fabrication. Since these curves were drawn, additional work has been done in extending the hard-zone curve of the 0.15-per cent-carbon steel, and the maximum variation in hardness from welding speeds of 4 in. to 18 in. per min. was found to be 65 points Brinell, or from 200 to 265 Brinell.

Carbon-molybdenum steel is being made into plate 4½

in. thick with 0.50 per cent molybdenum and the carbon ranging from 0.20 to 0.25 per cent for a minimum tensile strength of 70,000 lb. per sq. in. Carbon-molybdenum steel has been used in the refinery and boiler fields and in heavy plate for stationery boiler service.

A number of welding engineers have commented on the ease with which low-carbon molybdenum steels have been welded. If it can be proved that molybdenum substantially aids the weldability of steel, then this fact, together with its ability to keep hardening in the affected zone of the plate adjacent to a weld extremely low, makes carbon-molybdenum steel highly desirable for welding.

Aklo Heat-Absorbing Glass

With increasing attention being paid to the adequate insulation of modern railway passenger equipment, designers look critically on the large amount of window space which constitutes about one-third of the entire side and end wall area of a car. A comparatively new development, adapted to afford substantial assistance in solving the problem of heat transmission through windows, is a heat-absorbing glass, known as Aklo and made by the Libbey-Owens-Ford Glass Company, Toledo, Ohio.

Aklo is a plate glass of special chemical composition that gives the glass the ability to absorb infra-red light rays. It has a special coefficient of expansion, transmits a high amount of visible light and has a slightly greenish cast. In sunlight, the infra-red rays are heat rays and include one-half of the heat from the sun. Thus, Aklo absorbs approximately one-half of the heat of the sun's rays. When a ray of sunlight passes through glass, 5 per cent of the heat is reflected by the surface of the glass, 48 per cent is absorbed by the pane of Aklo, and the remainder, equaling only 47 per cent of the original sun's heat, is transmitted directly through the Aklo glass. These percentages are clearly indicated in the illustration which shows a ray of sunlight transmitted through a double glazing of Aklo and ordinary glass. When the ray of sunlight has passed through the outside pane of Aklo, it carries only 47 per cent of the sun's original heat, and as it passes through the pane of ordinary glass on the inside, 5 per cent of the heat is again reflected, resulting in only 42 per cent of the heat in the original sun's rays falling directly on the passengers or interior of the car. This promises to answer in a large measure the problem of insulating passengers from the uncomfortable direct summer sun rays.

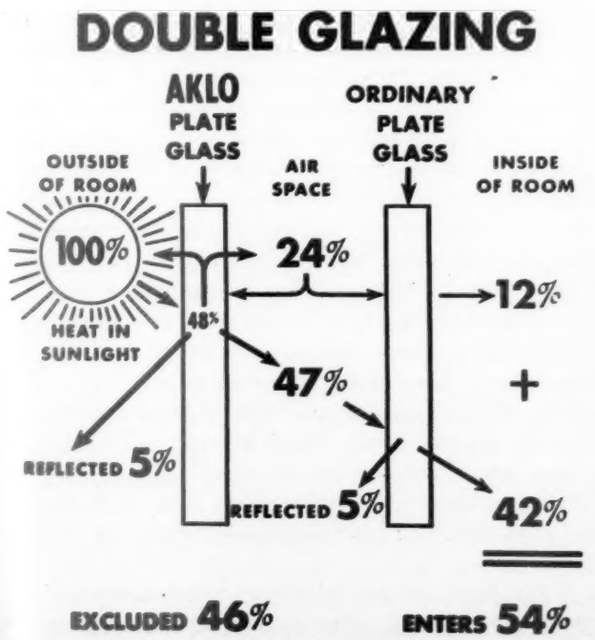


Diagram showing reduced transmission of the sun's heat through a double-glazed window, comprising one pane of Aklo plate glass and one pane of ordinary plate glass

If the railway car is air conditioned, this glazing system will also have an economic effect in reducing the car's air-conditioning costs. By reference to the diagram, it will be seen that of the 24 per cent of the sun's heat which is conducted toward the inside of the single pane of Aklo glass, that amount of heat only will be conducted into the air space in the recommended double glazing. This 24 per cent will then be again conducted half inside and half outside, or 12 per cent of the sun's heat will enter the car through conduction. Thus, the Aklo double glazing will allow a total of only 54 per cent of the sun's heat to enter the car, and thereby favorably affect air-conditioning costs.

Tests conducted at the University of California are said to have shown that, under maximum summer sun rays in that locality, ordinary glass transmitted 325 B.t.u. per sq. ft. per hr. Under the same conditions, it was found that Aklo glass transmitted only 195 B.t.u. per sq. ft. per hr., thus indicating how air-conditioning costs will be reduced and passenger comfort increased by the use of Aklo heat-absorbing plate glass. The use of this glass also tends to reduce the formation of condensation in double-glazed windows.

Railway Equipment Service Failures

(*Continued from page 174*)

cut into the fillet. Instances of this sort emphasize the fact that every possible precaution must be taken, from start to finish, to make things of this kind impossible.

At the risk of becoming tiresome I want to again emphasize the fact that square corners are an abomination on any reciprocating part, and frequently also in the case of simple revolving parts. A steel manufacturer had complaints that his steel was of poor quality and an investigator was sent out to study the case. He found that spindles used in a manufacturing plant, made from his steel, were failing in large numbers, whereas the spindles originally supplied by the manufacturers of the machine failed only occasionally. Critical examination indicated that the original spindles had a well proportioned, smooth fillet, while the ones made from his steel by a machinist in the spinning factory machine shop had a square corner in each case. Instructions were given to see that proper fillets were made and no further complaints were received as to the quality of the steel.

An improperly finished axle on a locomotive may cause a wreck costing a quarter of a million dollars. Improperly finished parts on locomotives and railroad equipment may cause damage varying all the way from this high sum to $15 for a new crank shaft on a modernized hand car, plus the time and service wasted because of having no fillet, or a poorly and roughly made fillet. Surely this potential source of trouble and expense is worthy of the most careful and critical attention on the part of the designers and all those having to do with the manufacture and maintenance of such parts.

EDITORIALS

Modern Facilities Needed More Than Ever

The current recession in business, with its accompanying necessity for the curtailment of expenditures for maintenance of equipment brings home again to every shop and enginehouse supervisor the increasing difficulties of providing serviceable equipment and keeping it within the limited expense budgets. It has also brought home the fact that, in some respects, many roads are not in as favorable a position to meet the present situation as they were in 1932 and 1933.

An analysis of maintenance operations, as far as locomotive repair work is concerned, for the past two and one-half years will disclose the fact that most roads did a remarkable job of keeping pace with the increased volume of traffic during that period and at the same time were able to catch up to some extent on deferred maintenance. Under present conditions of operation it is quite probable that the roads are again running out considerably more locomotive mileage than they are restoring.

Many things have happened since 1930 that have a marked influence on the ability of a road to maintain motive power in normal condition. By that is meant the ability to restore each month as much locomotive mileage as, or a little more than, has run out and to maintain available mileage at least at 50 per cent of the potential, or assigned, mileage. In the intervening seven years the locomotive inventory has increased in age, because the normal number of replacements has not been made each year. Increased age, in itself, would not be so serious were it not for the fact that the unit costs of maintenance go up with the increase in age. Therefore, on the age basis alone the average locomotive of 1938 will cost more to maintain than the average locomotive of 1930. In addition, the facilities with which locomotives are maintained in the enginehouse and in the shop have not only grown older, less productive, and more expensive to maintain, but the situation with respect to replacements is more serious than with motive power, for the reason that the relatively small amount of excess funds available for capital investment has, of necessity, been spent mostly for motive power and rolling equipment. This statement is made with proper regard for the fact that more shop machinery and tools were purchased in 1937 than in any year since 1929. But, it must also be remembered that 10 per cent of the shop-machinery inventory of 1930 has been retired because of obsolescence.

Aside from the above factors, railroad freight rates, while recently slightly increased, have been inadequate and substantial increases have been made in taxes and in wages. The increase is particularly significant when its effect is traced down to shop operation. Just as an example, the allowance for labor on a Class 3 repair job on a modern locomotive in a certain shop was approximately $4,500. At the wage rate existing before the recent advance this amount would produce about 375 man-hours of labor more than it could pay for at the present time. These 375 man-hours may more easily be visualized when it is pointed out that it amounts to over 46 eight-hour days. Any foreman can understand what this means in terms of work accomplished. To the foreman of today it also means work that may not be done.

The plain facts of the present situation can not be ignored. Every railroad man, from the general manager to the gang foreman, knows that it is impossible to continue for long to spend more than is earned. In an operation such as that of repairing locomotives a large part of which is a mechanized job, there is, fortunately, a solution by way of the installation of modern shop facilities. The present conditions afford an opportunity to study the value of such facilities.

Who Gets the Wage Increases?

On April 29 the Association of Railway Executives announced its decision to proceed under the provisions of the Railway Labor Act to secure a 15 per cent reduction in wages of railway employees. This action was taken following the refusal of the railway labor executives to discuss a voluntary—and temporary—wage reduction with the railway executives. Under the provisions of the Railway Labor Act the railway executives are required to give employees formal notice of a proposed reduction and to bargain collectively with the representatives of the employees. If both collective bargaining and intervention by the government's mediation board fail, either of the parties may decline to arbitrate. Following such an impasse the President may appoint an emergency board to hear both sides and report with recommendations which, however, are not binding on either side. Following a delay of 30 days the railways may then put the proposed reduction of wages into effect.

Throughout the several months required for the completion of this long process, no doubt, appeals will be made for the support of public opinion by both sides. Just how public opinion will crystallize in the end is a

matter which only the future will determine. There are some indications, however, that the public regards railway employees as a very highly favored group and is inclined to believe that they are probably too highly paid under present circumstances.

This trend in public opinion is based largely on the present status of the train-service brotherhoods, who are the "railway employees" in the popular mind. The present compensation of other groups of railway employees is probably not out of line with that of employees in industry generally. A strong case can be made out, however, for the proposition that wages throughout industry are too high for the greatest good of the greatest number of the wage earners themselves under present conditions. High wages in industry entail high prices of the products of industry. If all persons were employed by industry, the effect of high wages would in a measure be self-canceling. There are many groups in our population, however, whose earnings are not benefited by the wage increases of industrial workers. To them higher prices means curtailed consumption of industrial products and this means fewer jobs and less earnings for those whose wages have been increased.

This is the way it works out in industry, particularly at a time when demand is at a low ebb and there is a general lack of confidence. The railroads, however, have no control over the prices they charge for their services. To offset the wage increases of last summer and fall they asked for a rate increase. But the amount of the increase finally granted by the Interstate Commerce Commission is inadequate to offset the increase in expenses caused by the wage increases. With this lack of control of the price they charge for their services they are left with no recourse but to cut all expenses to the bone. This means less work for railway employees, particularly those employed in maintenance operations in which the effect of considerable postponement can be absorbed without disastrous consequences.

From the standpoint of railway-shop employees a decrease in wages such as the railways are asking for will not be without its favorable aspects. Unlike the train-service brotherhoods, whose employment is largely controlled by the volume of traffic offered to the railroads, a reduction in wages will effect some increases in employment in equipment-maintenance operations. The favored employees who have not been laid off may suffer some decrease in monthly earnings but this will probably not be as great proportionately as the cut in their hourly rate. Other employees will be taken back, however, and in all probability the greatest good to the greatest number of employees themselves will thus be best served.

This is merely a reversal of the process which took place last fall. Following the wage increase to the non-operating employees, there were immediate reductions in the hours of shop labor paid for by the railroads which brought back the total compensation paid to approximately the figures prevailing before the increase went into effect. On the other hand, when the increase in the wages of the train-service employees went into effect in October, they were accompanied by an increase in the hours of labor paid for because there was an increase in the volume of traffic during that month.

And when the time comes for consideration of a restoration of any part of such reduction in wages as may become effective during the next few months, the 83 million dollars (in 1937) which the road train-service employees received for time not worked should not be forgotten.

How About Apprenticeship?

Early in the present century the New York Central and the Santa Fe set the pace for the railroads—and industry as well—in introducing improved apprentice training methods in the mechanical department. George M. Basford, with statesmanlike vision, foresaw the need of better trained workers in the mechanical department as locomotives and cars were increased in size and capacity and improved in the interests of greater efficiency and economy of operation. His advocacy of better apprenticeship methods, in his paper before the American Railway Master Mechanics' Association in 1905, and his continued hammering on this question in the columns of the American Engineer and Railroad Journal, the predecessor of the *Railway Mechanical Engineer,* were largely responsible for having available in railroad service during the World War and postwar years, a reasonably good supply of well-trained mechanics and also a large number of well-equipped supervisors, who had been developed more or less as a by-product from the improved training systems.

What about the mechanics for tomorrow? The number of apprentices was greatly reduced during the depression, and in the effort to hold down expenses most of the training systems were largely thrown into the discard. These facts are generally recognized and have been a matter of great concern to railroad mechanical department officers. The difficulty is accentuated by the fact that marked progress has been made in locomotive and car design to meet the exacting present-day conditions, and that higher standards of workmanship must be insisted upon in the future. In addition to complications in the design and the addition of special equipment, new materials have been introduced which require special treatment and changes in maintenance and shop practices. In many instances much closer tolerances must be observed.

Apprentice training methods should be introduced which will protect this situation and furnish an adequate supply of well-trained mechanics for the future. A rough survey indicates, however, that in most instances the railroads have gone back to almost primitive methods in dealing with the apprentices. This is re-

flected to a certain degree in the extracts from letters from apprentices which will be found upon the Gleanings page of this issue. Unfortunately, reports from industry indicate that much the same thing is true in other fields, although a determined effort is now being made by the Federal Committee on Apprentice Training of the United States Department of Labor to improve the situation. A number of states have now established apprenticeship councils to study conditions within the individual states and to stimulate a larger interest in these matters on the part of industry at large. Certainly there is no lack of evidence on the railroads as to the value and importance of the work done by well organized apprentice training systems in the past, and to warrant a resumption of this activity, and in a way which will meet modern conditions, on a sufficiently large scale to furnish the more highly trained personnel which will be required in the future.

Servicing Streamline Trains

The proper servicing of passenger trains at terminals has always constituted an important and quite expensive operation, greatly augmented in recent years by the large proportion of air-conditioned equipment which involves provision for precooling, re-icing, or attention to mechanical details, in the case of power-operated air-cooling apparatus.

To the above requirements is now added the necessity of unusually quick turn-around service, in order to secure maximum availability and use of expensive modern trains. The necessity of careful planning and organization of terminal car-handling forces for the satisfactory performance of this work is obvious. An adequate force of employees, experienced in the cleaning, inspecting and repairing of these trains, is of fundamental importance and, when the layover time is exceptionally short, it is frequently necessary to start this conditioning work almost as soon as passengers are out of the arriving trains.

Next to an effective terminal organization, and in some respects even more essential, is the provision of adequate mechanical facilities, located adjacent to passenger terminals, and designed to facilitate the quick and effective performance of all inspection and repair operations. The experience of the Chicago, Burlington & Quincy in handling its fleet of Zephyr trains at the Chicago terminal, for example, has indicated the value of installing repair tracks of adequate length, preferably equipped with inspection pits and necessary drop-pit and crane facilities for changing wheels, or if necessary complete trucks.

Another example which might be cited is the Daylight trains of the Southern Pacific which are inspected, cleaned and serviced in the Pullman cleaning yard at San Francisco, Cal., where a raised inspection and repair track has been provided for the efficient handling of this work. The track was raised by placing 12-in. timbers longitudinally over the ties with rails on top of the timbers and a gradual slope at each end to the level of other tracks. This raised track provides an excellent opportunity for the critical inspection and repair of all parts of the trucks, brakes and air-conditioning equipment below the underframe. Two hydraulic-operated drop tables are provided on this track for the quick change of wheels when necessary.

On each side of the Daylight servicing track, there is a concrete pavement with suitable gutters to take care of the large amount of water which is required to wash the train thoroughly every night. Electric lines, with outlets for charging and testing, and easily accessible water and steam connections are also provided. A general overhead lighting system gives ample illumination for exterior cleaning, and portable electric lights are available for lighting underneath the cars and for other use where special illumination is required.

Portable-cleaning platforms on wheels, as well as portable material and tool wagons, afford a means of servicing and cleaning the car exteriors at a minimum cost. The interior of the train is serviced by assigned, specialized crews, vacuum cleaners being used exclusively for cleaning carpets, upholstery and drapes and thus avoiding unnecessary circulation of dust in the cars.

Unquestionably the provision of all of the mechanical and labor facilities needed for the efficient servicing of modern passenger trains introduces a large element of cost into railway operation but, considering the high first cost of the equipment and the necessity of getting adequate returns on the investment, as well as meeting the exacting demands of the public, it is obviously false economy to stint on expenditures essential in modern passenger-car terminal-servicing operations.

New Books

MECHANICAL WORLD YEAR BOOK, 1938. *Published by Emmott & Company, Limited, 31 King Street West, Manchester, England. 210 pages, 4 in. by 6½ in. Price, 1/6 net.*

An entirely new section on the subject of Electric Arc Welding is contained in the 1938 edition of the Mechanical World Year Book. It describes the types and properties of electrodes, explains the process in detail, and gives instructions for the various methods of welding and for welding in different positions. Welding design is also discussed and methods of calculation given for butt and fillet welds. In order that two consecutive editions of the book might provide a greater store of data, sections are now alternated. In the 1938 edition the section on Presswork, omitted from the 1937 edition, has been brought back and the section on Metals and Alloys omitted.

Gleanings *from the* Editor's Mail

(The Apprentices Speak)

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Shoddy Apprentice Training

Instead of the various shop foremen sticking to the schedules, they put us on jobs and then forget about us. We either have to remind them about our time being up on that certain job, or else remain there until we are so far past the date of changing that we lose out on some other position in the shop. Is this fair to us?

Encourage Apprentices to Study

Give apprentices more time in classroom study during working hours, with proper supervision to combine classroom theory with shop practice. Have speakers, experts in their fields, talk to the apprentices at regular meetings. Create an incentive among the apprentices for outside study. Have regular periods of visitation to other repair shops or other industrial plants to see how it is done elsewhere.

Technical Training Overlooked

The officials concerned do not take the interest they should in teaching their future machinists. We apprentices deserve more book work, to explain the technical side of some of this machine work. All they seem interested in is securing a good day's work, regardless of what kind it may be. I think they should supply us with printed material to explain this work along with the actual experience. As it is, all we get we have to secure ourselves.

Apprentice Critical of Conditions

The place in which we study is poor. It is dirty and has improper lighting and ventilation. I would not ask anyone to make a neat drawing when everything you touch is covered with coal smoke. When I applied for a job as apprentice the application called for the type of work wanted. I didn't even know what they had to offer, so I put down machinist. I would suggest a list of the training offered, wages paid, amount of time required to complete a course for the young applicant to read. He would know then what he was getting into and what was expected of him. I worked six months before I obtained all of this information.

An Investment for the Future

It is my opinion that the apprentice is too often used as a means of low-cost production, rather than as a student preparing to be a future skilled workman. Also, it seems that apprentice training could be improved by encouraging the student to make more of a study of his work. By this I mean that he should be given the opportunity to read books pertaining to his work and to spend additional time outside of working hours in study. With this in mind, it would necessitate the choosing of boys who are ambitious and apt to learn. Those employing apprentices should take greater interest in them and make every attempt to properly educate them as an investment for the future.

Furloughed Apprentices

Since we have been furloughed I have kept in touch with several of the other fellows and, like myself, they have found it difficult to secure employment. There are several reasons for this. For one, work is generally slack, as everyone knows. Second, not having finished our apprenticeship, concerns have little desire for our service. And lastly, the fact that we are employed by the railroad; we have found that most concerns won't even accept an application from us, because they claim that when the railroad sends for us again we will return. They claim that this turnover in labor is costly and decreases plant efficiency.

Few Apprentices Know "Why"

In the earlier days regular apprentices were given more training in blue print reading, drawing and a better understanding of mechanism or the fundamentals of electricity. Today their work consists mainly of actually doing the work after observing the machinist or electrician do it. Few know "why" they do what they do and the majority have gained the attitude of "who cares". This attitude could be overcome by giving encouragement to those apprentices who take the initiative to go to some night school to better themselves for their work, rather than let the apprentice go four years with the idea that he'll get no further than the one who does not broaden his thinking ability.

Give Apprentices More Seniority

There is little assurance when an apprentice completes his time that he will have a job awaiting him. With the seniority rule in effect and recent reductions in forces to stabilize employment making for a long list of laid off employees, the apprentice with but one year of seniority (as a mechanic) granted him for three or four years of service, has a small chance for regular employment with the company he served his time for. It seems to me that if a company spends a sizeable sum in training a man it should take steps to retain him when he finally becomes valuable to them because of experience, gained during his training. A step in the right direction that might help would be to give a graduate apprentice more seniority.

More Trained Mechanics Needed

I read an article in the *Railway Mechanical Engineer,* written by an official of the Denver & Rio Grande Western (H. J. Schulthess, in October, 1937, issue, page 437) on apprentices and their training. This official stated that what the mechanical departments of the railroads needed today was trained mechanics, and that the only way to get trained mechanics was through apprenticeship training. I thoroughly agree with this, but evidently some of the officials of our road do not. If they would get out of their offices and come to the various shops to check up on the work being done by their mechanics today, I am sure that they would also realize that what the mechanical department needs is more trained mechanics.

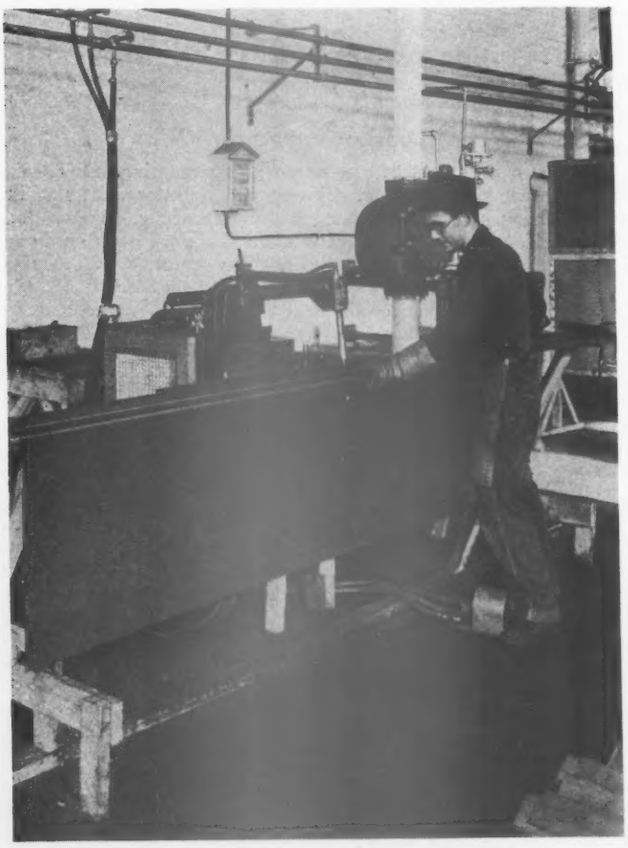
With the Car Foremen and Inspectors

Building

Light Welded Box Cars

Pullman-Standard utilizes special welding jigs and equipment in constructing 200 cars at Michigan City Plant

Two hundred lightweight welded 50-ton box cars, now being built by the Pullman-Standard Car Manufacturing Company at its plant, located at Michigan City, Ind., are notable not only for their efficient lightweight welded design but because the structural materials and fabricating methods used promise unusual serviceability, long life and freedom from maintenance cost. The car design, developed by Pullman-Standard after extensive research and experiment over a period of several years, effects a saving in weight of about 4½ tons from that of a conventional Association of American Railroads standard box car of the same dimensions.



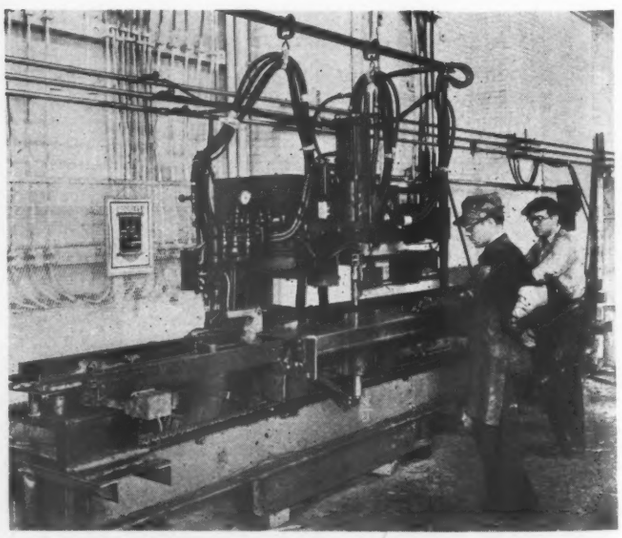
Spot welding miscellaneous side parts

The car is made of high-tensile low-alloy steel, utilizing arc welding, spot welding and riveting wherever each can be employed to the best advantage. The approximate footage of each, per car, is as follows: arc welding, 1,030 ft., or 27.7 per cent; spot welding, 2,601 ft., or 70 per cent; riveting, 90 ft., or 2.3 per cent. The car, though normally of 50 tons' capacity, will actually carry 133,400 lb. of revenue load. It has the following dimensions: inside width, 9 ft. 2 in.; inside length, 40 ft. 6 in.; inside height, 10 ft. ½ in. The car weighs 35,600 lb., and has a ratio of lading to rail load of 78.9 per cent, which may be compared with 73.7 per cent for the A. A. R. car. Comparative weights of detail parts in the two cars and the structural materials used are shown in the table.

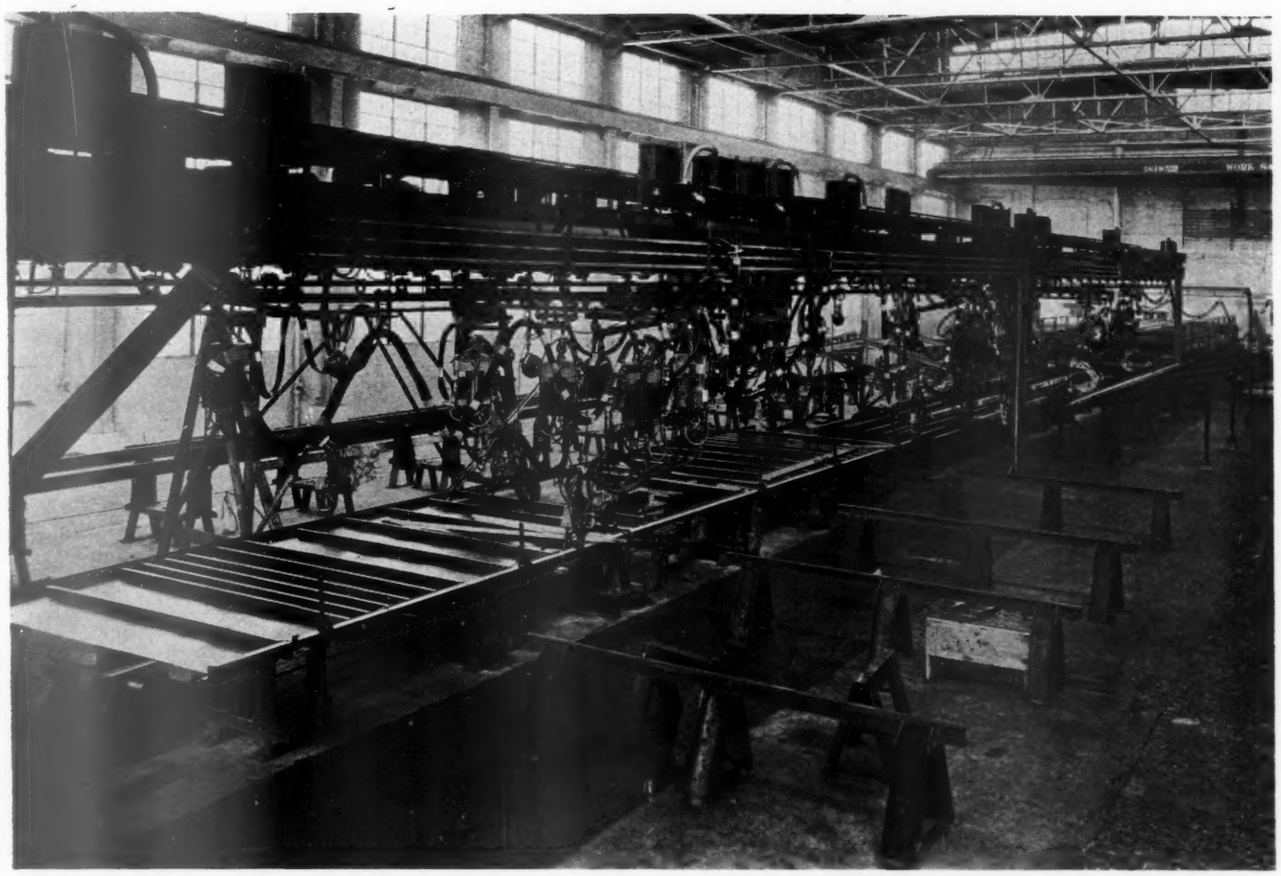
Spot-Welding Operations and Equipment

In order to produce these lightweight welded cars, a new shop was erected and a considerable amount of automatic and portable spot-welding equipment installed. With the exception of the roof application to the steel body, all spot-welding work is concentrated in this one building.

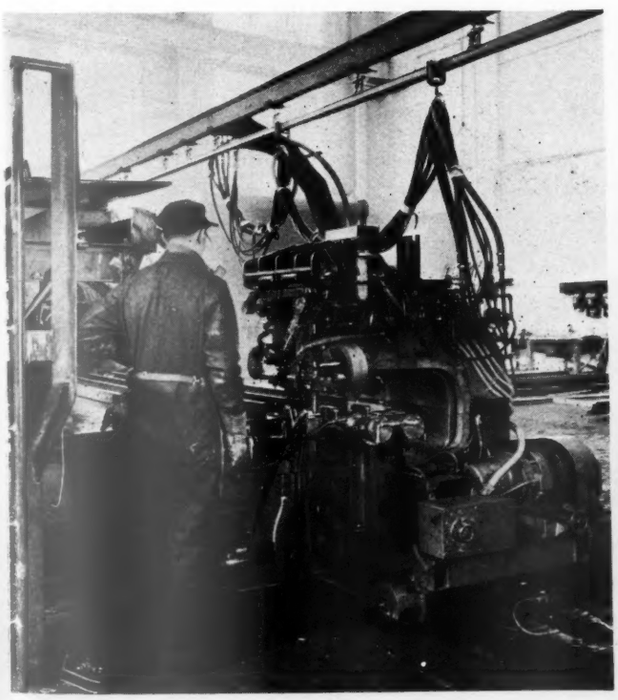
The resistance spot-welding method used is one in which the parts are overlapped and gripped between two electrode points through which a heavy current is passed and pressure applied to make the weld in a single spot. The temperature, timing, and pressure varies according to the type, thickness, and number of layers of material.



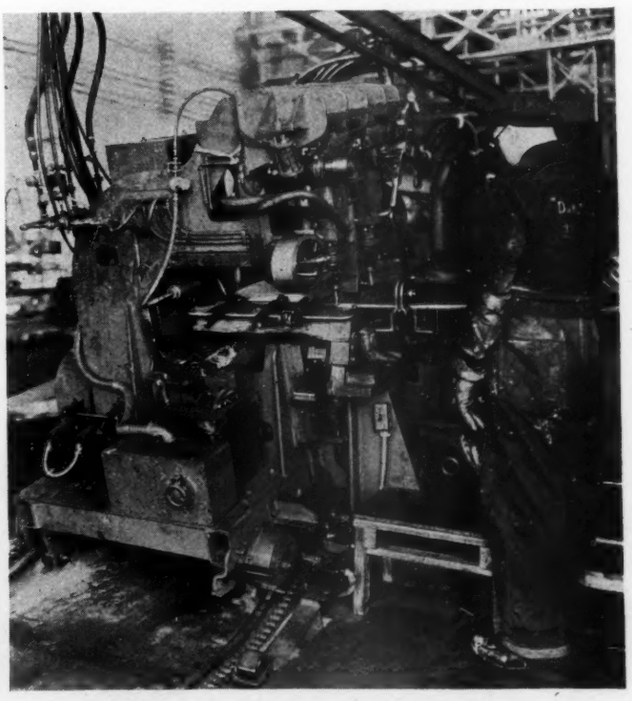
Spot welding posts to side sheets



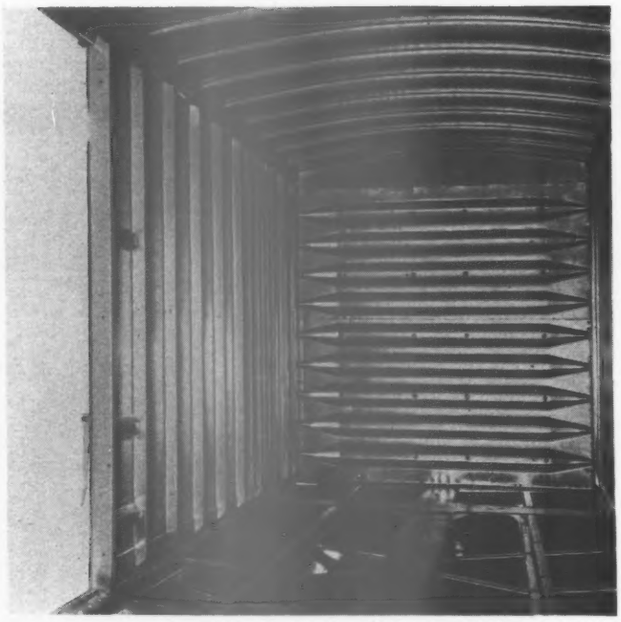
Special jigs and equipment used in fabricating complete car sides by spot welding



Side-sheet spot-welding machine in operation



Roof spot-welding machine in operation



The assembled car structure

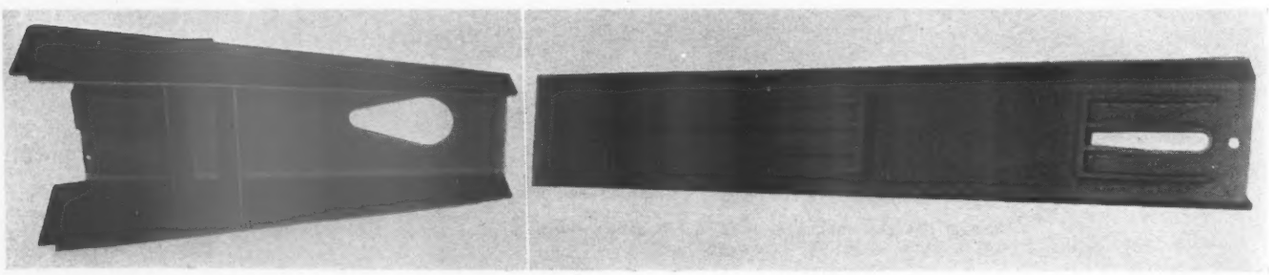
Every main and sub assembly is made in a special jig to assure uniform accuracy.

Close supervision, continued inspection, and daily testing of welds is carried on at all times to establish good welding. Each day a test spot-weld specimen is made by each machine and is tested to insure correct timing, temperature, etc. In addition, inspectors sound each button on every bench assembly to guarantee a continuous perfect quality of weld.

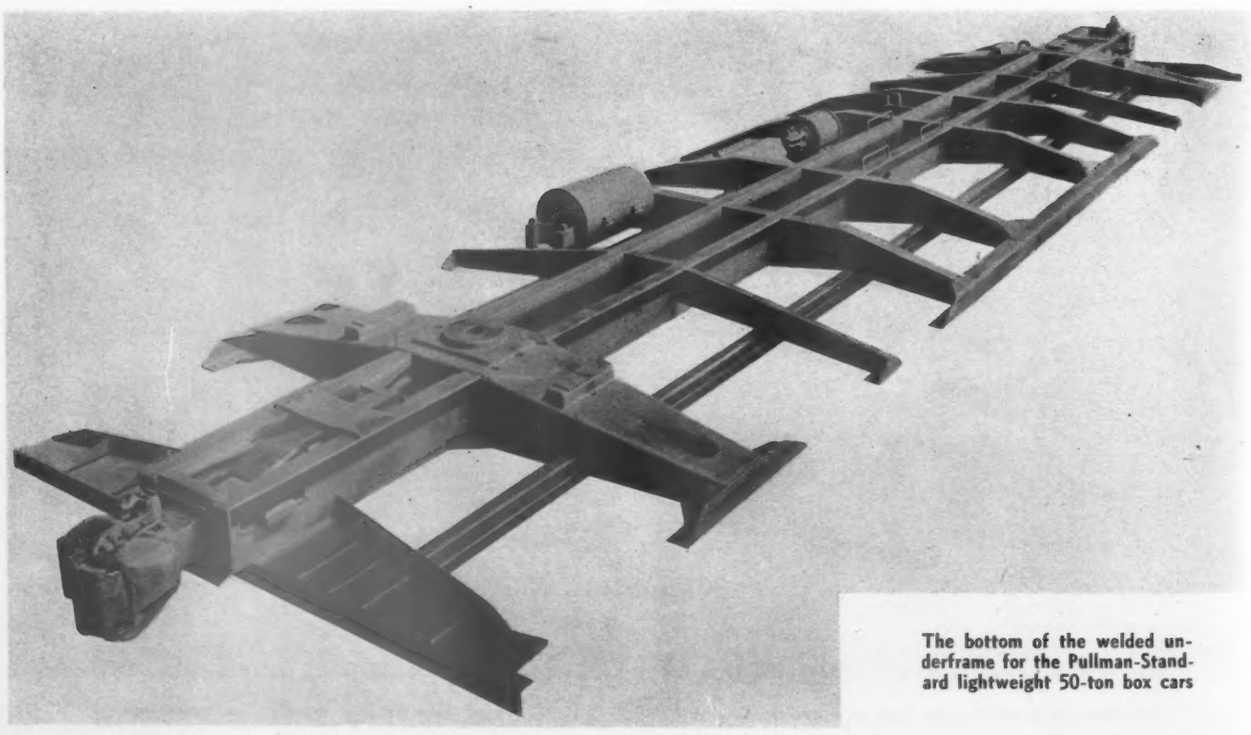
The spot-welding equipment, especially designed and installed to make use of this new method of building cars, includes two non-indexing automatic double-head 75-kv.-a. machines; two indexing automatic single-head 100-kv.-a. machines; four stationary spot welders, 50 kv.a.; nine portable tools, 100 kv.a.; and 18 portable tools, 75 kv.a.

The non-indexing automatic machines are used for spot welding the side-sheet assembly and the roof-sheet assembly. The indexing automatic machines are for the door-sheet assembly and the door-post assembly. The stationary spot welders are used for welding the reinforcements on the roof carlines and side posts, as well as for other small miscellaneous sub-assembly work.

All the machines and transformers were built by a company which has had long experience in construction and using this type of equipment. The electronic prin-



Left: Body-bolster diaphragm—Right: Arc-welded draft sill



The bottom of the welded underframe for the Pullman-Standard lightweight 50-ton box cars

ciple of timing is used on most of the machines, with air timing on the balance. The contactors and operating valves of the electronic timers are designed to meet the requirements of this particular service.

All of the portable tools were especially designed to handle some individual feature of sub and final assembly. These tools are used for applying the side plate, side sill, post connections, etc., to the sides. Other portables are also used for applying the roof to the car and the final assembly of the side doors.

The spot-welding machines range in capacity from 50 to 100 kv.a., most of the machines being rated at 75 kv.a. The electric power supply is at 60 cycles and 480 primary voltage. The welding current is made available at 14 volts, 5,000 to 6,000 amp. The mechanical pressure between sheets being welded varies from 700 to 4,000 lb. depending on the thickness of the material, the average pressure being 1,200 lb. The welding time varies from 6 to 45 cycles, depending on the type of tool and thickness of materials, with an average of 10 cycles.

Comparative Weights and Structural Materials Used in Pullman-Standard Lightweight Welded 50-Ton Box Car and A. A. R. Standard Car of Equivalent Capacity

	Pullman-Standard car	A. A. R. standard car
	Weights	
Car Body	21,000 lb.	29,100 lb.
Trucks	14,600 lb.	15,400 lb.
Complete car	35,600 lb.	44,500 lb.
Load limit	133,400 lb.	124,500 lb.
Ratio of lading to rail load	78.9 per cent	73.1 per cent
Underframe	5,797 lb.	7,879 lb.
Sides	3,532 lb.	5,933 lb.
Roofs	1,190 lb.	2,086 lb.
Doors	527 lb.	724 lb.
Door fixtures	415 lb.	556 lb.
Ends	1,209 lb.	2,350 lb.
	Material	
Side sheet	.05-in. H. T. low-alloy steel.	.10-in. O. H. steel.
Roof sheet	.05-in. H. T. low-alloy steel.	14-gage O. H. steel.
Door sheet	.05-in. H. T. low-alloy steel.	.10-in. O. H. steel.
End sheet—bottom	1/8-in. H. T. low-alloy steel.	1/4-in. O. H. steel.
End sheet—top	3/32-in. H. T. low-alloy steel.	3/16-in. O. H. steel.
End plate	1/8-in. H. T. low-alloy steel.	Integral with top sheet.
Center sills — AAR Z-section	31.3-lb. 11/32 in. thick, 18.4 sq. in., high-carbon O. H. steel, 36,000 lb. min. yield point.	36.2-lb. 13/32 in. thick, 21.3-sq. in. O. H. steel, 30,000 lb. min. yield point.
Side sills	6-in. by 3 1/2-in. by 1/4-in. H. T. low-alloy steel.	6-in. by 3 1/2-in. by 5/16 in. O. H. steel.
Side sill reinforcement	7/32 in. pressed channel.	6-in. bulb angle O. H. steel.
Side plate	5/32-in. H. T. low-alloy pressing.	3-in. O. H. steel Z-section.

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In spot-welding the roofs and sides, welding rates up to 250 spots per min. in the double-head machine are attained. The spacing of spots on the sides consists of two rows, spaced vertically 3/4 in., staggered, with 7/8 in. between the rows of spots. The spacing of spots on the roof consists of two rows of spots, staggered 1 in., with 1 in. between rows of spots.

Arc-Welding Operations

The arc welding employed is the shielded-arc type in which coated electrodes are used. The type and size of rod depends on the position, size of weld, and kind of material. The jigs for arc welding are all constructed to permit down-hand welding.

Less than one-third of the welding footage in each car is made by arc welding, which is concentrated primarily in fabrication of the underframe, application of door fixtures, etc. The riveting employed is that along the corner post seam for the final application of the ends to the car and along the side sills for the final application of the sides to the underframe. At the present time, riveting appears to be more advantageous than either method of welding for these particular joints.

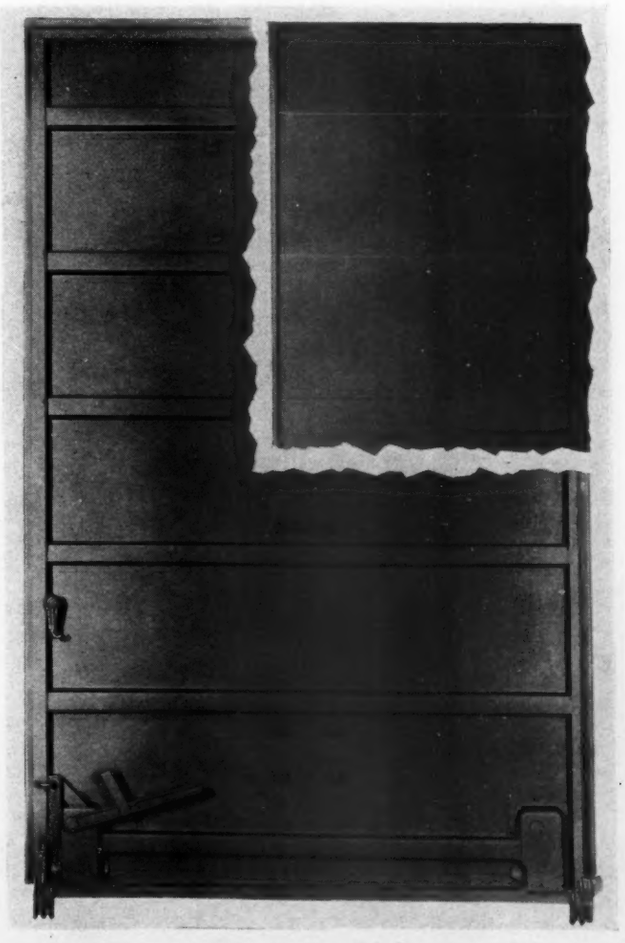
In the end-sill assembly, the end sill is a 1/8-in. Z-pressing, made of high-tensile low-alloy steel. The Z-shape gradually reduces in depth toward the side sill where it is joined and reinforced by a 1/8-in. flanged gusset. The web and depending flanges are stiffened by four 1/8-in flanged stiffeners applied on each side of the center sill.

In the side-post reinforcement assembly, the side sheets are .05 in. thick high-tensile low-alloy steel with Z-posts pressed integral and reinforced with .05-in. pressed angles.

In the side-sheet reinforcement assembly, the side sheet at the bolster is stiffened with two .05-in. high-tensile low-alloy steel pressed Z-sections reinforced with .05-in. pressed angles. The side sheet, next to the bolster is reinforced with one Z-bar and angle of the same design as that on the bolster sheet.

Other sub-assemblies include application of the auxiliary to the main door post, application of the auxiliary and main door post to the side sheet, and reinforcements to side sheet at the bolster.

In the automatic spot-welding of side sheets, the individual sheets are welded together with two rows of spots spaced vertically 3/4 in., staggered with 7/8 in. between rows of spots, as mentioned. The machine is designed to deliver the side-sheet sections automatically to the welding position where a composition flux is applied previous to spot welding in order to seal the joints.



The side door of the Pullman-Standard lightweight welded box car. A portion of the inside of the door is shown in the inset

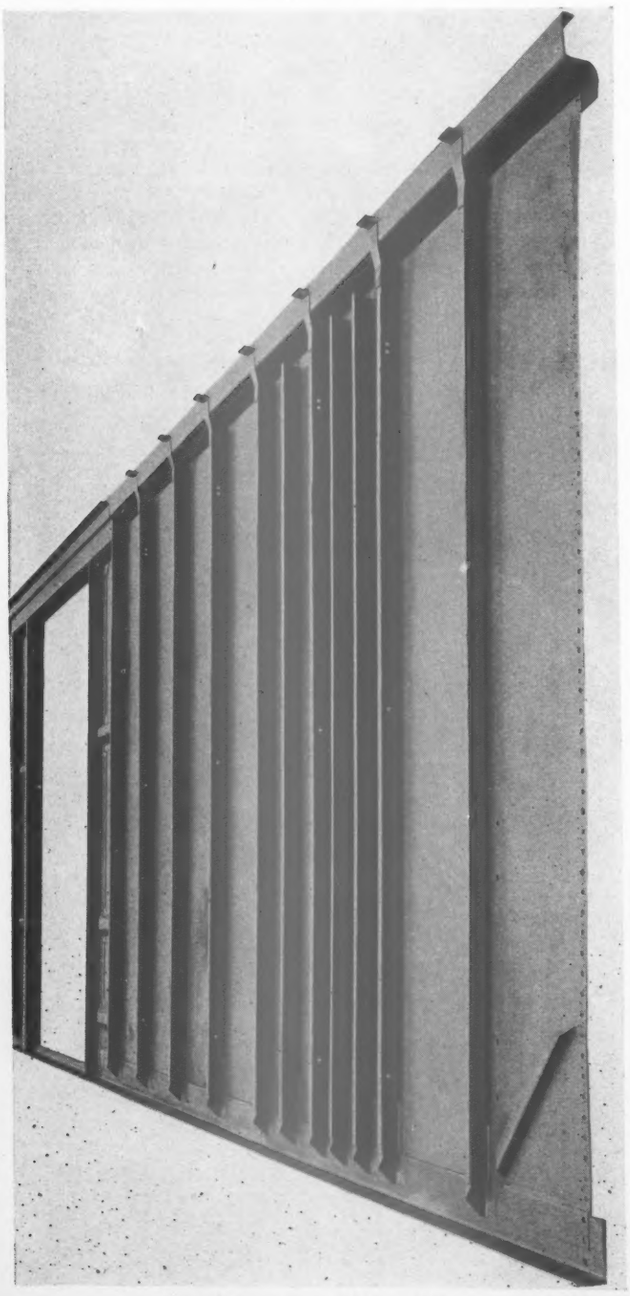
Side-plate, side-sill, side-post connections and gussets are applied to the assembled side sheets by means of portable spot welders at the next position.

The roof sheets are .05-in. high-tensile low-alloy steel with a Z-carline pressed integral and reinforced with a .05-in. pressed angle, spot-welded to each carline. The running-board saddle is spot-welded to the roof sheet and an automatic machine, similar to that employed in assembling the side sheets, is used to spot weld the roof-sheet sections together, using two rows of spots staggered, spaced 1 in. apart, with 1 in. between the rows.

Other assemblies include the spot-welding of door sheets, assembly of door sheets to door frame, arc-welding and riveting of door fixtures, etc.

Underframe Assembly in the Steel Shop

The underframe parts are assembled and united by arc welding in the steel shop where ample track facilities and equipment are available for the subsequent application of car sides, ends, roofs, etc.



Inside view of the car side

The center sills are A. A. R. Z-sections, reduced to $1\frac{1}{32}$ in., the two parts being joined by arc welding continuously at the junction of the top flanges. The cross-sectional area is slightly over 18 sq. in. total and is based on the use of high-carbon steel with a minimum yield point of 36,000 lb. per sq. in. and tensile strength of 60,000 to 72,000 lb. per sq. in.

I-section center-sill separators are located at cross ties and cross bearers. The draft sills are formed by the continuation of the center sills. The bolster center fillers, draft lugs and striker are built up integral with the center sills by arc welding of rolled bars. All parts of this construction are low-carbon open-hearth steel except the draft and buffing spacers, which are of high-tensile low-alloy steel.

The body bolsters are "bath-tub" type, $\frac{5}{16}$ in. thick, welded in one piece and reinforced where required. The body center plates are A. A. R. bowl type, welded to the underframe. The body side bearings are built up with $3\frac{1}{2}$-in. by $\frac{3}{8}$-in. wear plates.

The cross bearers, four per car, are built up I-sections with $\frac{1}{8}$-in. web and $4\frac{1}{2}$-in. by $\frac{1}{4}$-in. cover plates. The floor beams, two per car, are pressed in one piece, extending from center sill to side sill, being made of $\frac{1}{8}$-in. plate.

To provide bracing of the center sill to the car end, plates are welded to the center sill forming a T-section, which is welded completely throughout the width of the car to the end sheathing and at the corners to the side sills. Floor stringers, two per car, extend the full length of the underframe and are welded in place as shown in the illustration.

The various underframe parts are assembled upside-down in a special jig which holds them in accurate alinement while all underneath arc-welding operations are performed. The partially welded underframe is then turned over and all down welds made. The third operation is to place the underframe in a revolving jig which permits holding it in any position necessary for the completion of all underframe welding in the down-hand position.

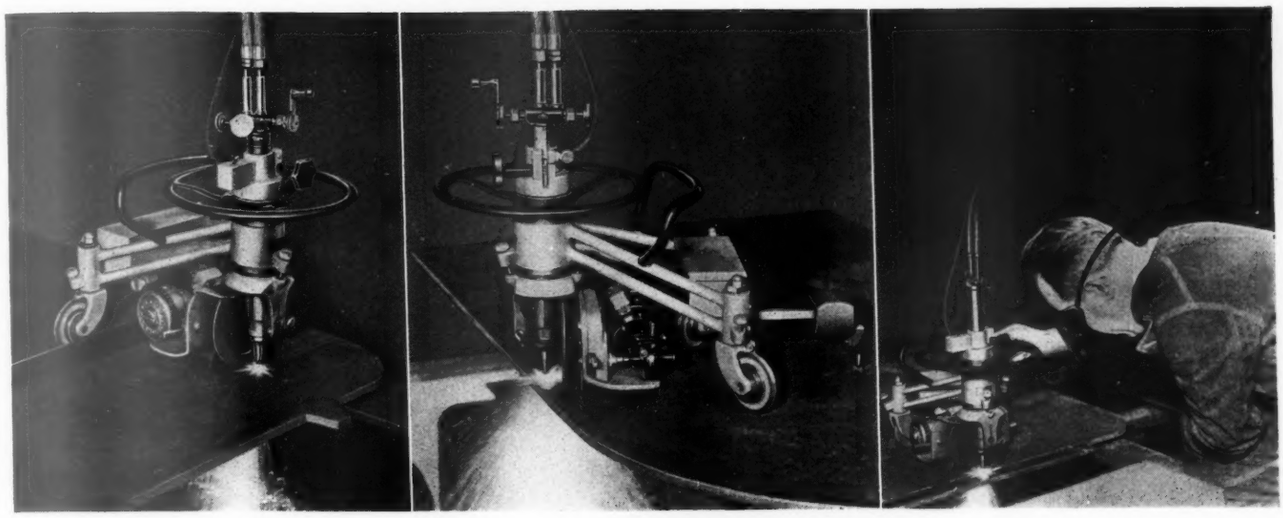
Finishing Operations

From the steel shop, the assembled car, including the underframe, car sides, two-piece pressed-steel ends, doors, etc., is moved to the wood erection shop where the inside wood lining and floor are applied, as well as the running board, safety appliances, etc. The car is then painted and stenciled.

Oxweld Portable Cutting Machine

The type CM-16 portable cutting machine illustrated, has been developed by the Oxweld Railroad Service Company, Chicago, Ill., for the shape cutting of steel parts. This machine is motor driven, compact, light, easy to manipulate and those engaged in railroad work find it useful in the shaping of steel plate, especially for car parts to be subsequently fabricated by welding.

For most work the machine can be set up and operated directly on the steel sheets without the use of a supporting table. When guided by hand, the CM-16 can be used for cutting irregular shapes to exact contour, and when used with a radius rod, the machine automatically cuts circles. It can also be operated on an angle-iron track for automatic straight-line cutting.



Oxweld Type CM-16 cutting machine operated (left) on an angle-iron track for straight cutting; (center) with a radius rod for circle cutting, and (right) hand-operated on an irregular contour

Its light weight, 45 lb. complete with blowpipe, permits the machine to be moved from job to job and operated with little more set-up time involved than in cutting with a hand blowpipe. It cuts to the edge of the plate and stops without running off the plate. Thus the machine requires a minimum of attention and permits the utilization of stock which would otherwise be wasted.

The Oxweld CM-16 cutting machine is driven by a 110-volt electric motor, the speed of which can be set by adjusting a direct-reading speed indicator to permit cutting from 4 in. to 30 in. per minute. The starting switch is conveniently located adjacent to the blowpipe valves. A clutch disengages the driving mechanism and allows the operator to free-wheel the machine across the work with the motor either running or shut off.

The CM-16 is equipped with a precision cutting blowpipe, Type C-12R. The cutting of bevels is readily accomplished by the use of a special attachment.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.A.R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Paint Loosening and Peeling From Interior of Passenger Car

On February 2, 1936, the Chicago & North Western delivered one of its modern chair cars to the Union Pacific at Omaha in good condition. On February 21 the car was received at Omaha with the interior finish badly damaged. It was cut out of service by the U. P. and returned to the C. & N. W. without the issuance of an A. A. R. defect card. The owner repaired the car and submitted a bill to the U. P. covering the total cost of repairs amounting to $888.30.

The owner pointed out that the car had been set out on the U. P. at Sidney, Neb., because of damage to the steam line caused by the train striking two cattle. The car was unheated for a period of 18 hours during which outside temperatures averaged 18 deg. below zero. It was then placed on steam after which the damage to the interior finish occurred. The car owner maintained that this consisted of improper handling, since excessive expansion and contraction of the steel caused thereby resulted in the damage in question.

The handling line pointed out that the C. & N. W. offered its passenger cars to the U. P. in through-line service subject to provisions of A. A. R. Interchange Rules and with full knowledge of the weather and operating conditions in the territory through which the cars operate and with the understanding that the owner will assume the cost of repairs either interior or exterior not classified as handling-line responsibility. The U. P. also pointed out that its own cars are subjected to similar treatment which the C. & N. W. contended was improper care.

In a decision rendered November 11, 1937, the Arbitration Committee stated: "Paint loosening and peeling from interior finish of passenger equipment cars under the circumstances in question, is a car owner's responsibility. The contention of car owner is not sustained."—*Case No. 1757, Chicago & North Western versus Union Pacific.*

Questions and Answers On the AB Brake

Brake Cylinders (Continued)

287—*Q.—What precaution must be taken when assembling the cylinder?* A.—It is necessary to make sure that no foreign matter is permitted to enter.

288—*Q.—When the service or emergency portion has been cleaned or repaired in the shop, what kind of a test should be made?* A.—Test should be made only on a standard test rack according to a code of test furnished with the rack.

289—*Q.—After the valves have been replaced on the car, is a test necessary?* A.—Yes. Test should be made with the use of a standard single-car test device.

290—*Q.—How much pressure should be used in the supply line?* A.—At least 70 lb.

291—*Q.—What should be done before attaching the*

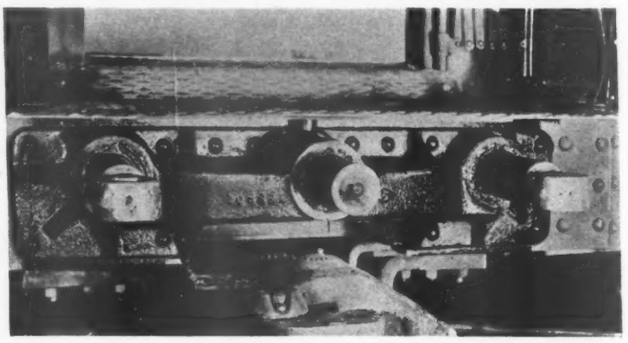
test device to the supply line? A.—The supply line should be blown out thoroughly in order to avoid the possibility of moisture and dirt getting into the test device or air lines.

292—*Q.—After the test device is connected to the air line at the supply end, what must be done before the other end of the device is connected to the brake pipe hose on the car?* A.—Move the device handle to lap position and open the cock in the supply line. There should be no escape of air from the device brake-pipe connection or its exhaust port.

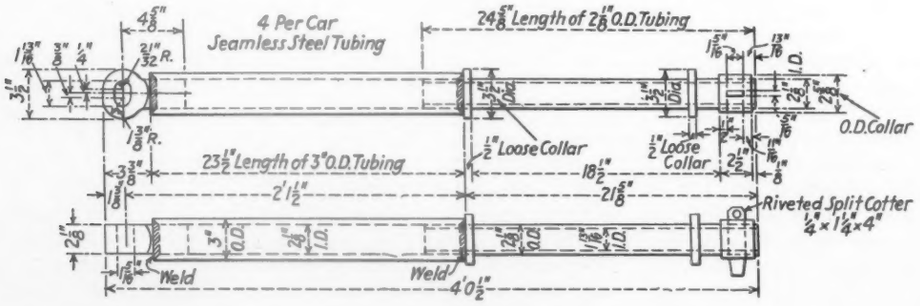
Passenger Car Buffer Stem Design

*By Glenn L. Davis**

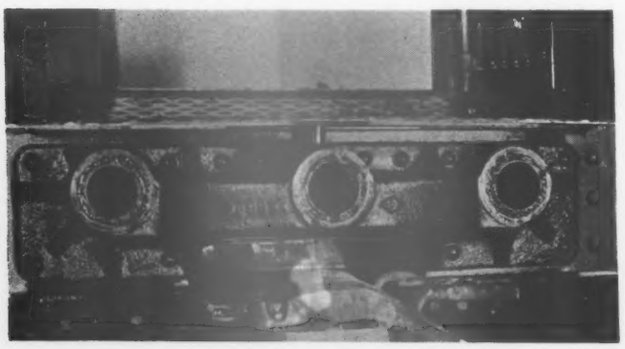
In recent years the elimination of noise in passenger cars has been the subject of much thought. Added insulation and the closing of cars incident to air conditioning have shut out much of the outside noise. Truck and buffer noises have, however, remained except where



The side and center buffer stems in place



Details of the side buffer stem



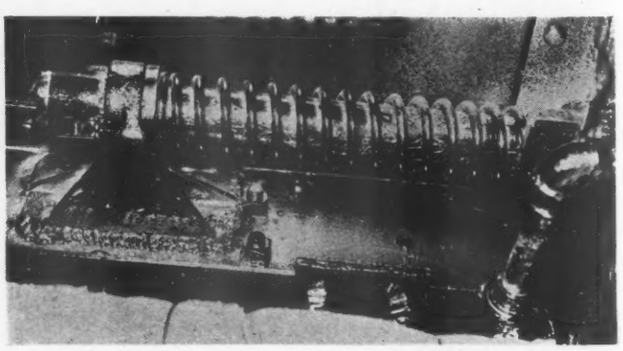
Passenger-car buffer designed to use round buffer stems of welded tubular steel construction

eliminated through design or the application of vibration-reducing, shock-absorbing material. One means of reducing buffer noise through design is described below.

The rectangular side and center buffer stems have been replaced with round stems fitting snugly in long Alemited bearings of steel tubing. Having only 1/32 in. clearance, the blows incident to the movement of the stems are very light. Having large projected area and being well lubricated they wear slowly and the maintenance costs are low.

Side stems are made of steel tubing for lightness and to reduce their cost. The smaller tube is inserted the correct distance into the large tube and welded. A forged-steel end, to which the diaphragm plate is attached, is provided with an oblong hole for the hinge pin. This hole is elongated sufficiently to provide the necessary clearances for curving. The stem is secured by means of a collar 2½ in. long, slipped over the inner end, both stem and collar being slotted for a ¼-in. by 1¼-in. by 4-in. riveted split cotter. The stem acts as a support for the buffer spring, which bears against two ½-in. loose washers. The inner end of the stem is supported in a steel casting provided with a liberal bearing which may be bushed with an insulating bushing or bored for the stem and lubricated.

The center stem is a 3-in. diameter round bar of proper length, operating in a long lubricated sleeve of steel tubing. Linoleum ⅛ in. thick encases the buffer and prevents it rubbing or striking the underframe.



Underneath view of a side buffer stem and spring

In order to minimize the side thrust on the buffer stems the diaphragm plate is lubricated with four Alemite fittings following the manufacturer's recommendations. Lubricating the diaphragm also reduces to some extent the noise of rubbing surfaces and lessens wear on the plates and the supports for the upper buffer mechanism.

* Drawing Room Supervisor, St. Louis-San Francisco, Springfield, Mo.

IN THE BACK SHOP AND ENGINEHOUSE

Taper Boring Bar Used With Drill Press

Side-rod knuckle-pin holes and crosshead wrist pin holes and piston-rod fits are bored at the Pen Argyle shops of the Lehigh & New England with the aid of a taper cutting boring bar on a drill press; the boring bar used for side-rod knuckle-pin holes is designed to cut a taper of 1½ in. per ft., while the boring bar used for the crosshead piston-rod fit is designed to cut a taper of ¾ in. per ft.

The boring bar has a No. 5 standard taper shank 9 in. long which fits the drill-press splindle. The boring-bar shank is bored to a diameter of 2 in. to receive the neck of the bar proper. The section of the boring bar below the neck is 3 in. in diameter and is milled with flat surfaces on opposite sides which are 15 in. long and has a taper of 1½ in. per ft.; the boring bar is slotted between the two tapered surfaces. Two 6-in by 1¾-in. by ½-in. slides are bolted together through the bar and attached by two ½-in. arms to the shank. One of the slides has a tool-holder lug for receiving the ⅜ in. tool bit which is held in place by a set screw.

When using the boring bar, the side rod is placed on the drill-press table and leveled. The boring bar is then set up as shown in the accompanying illustration. As the drill-press spindle revolves, turning the boring bar, the feed moves the drill-press spindle and the boring-bar shank downward. As the spindle and shank descend, the flat slides and the tool follow the taper on the bar, removing enough metal to clean up the knuckle-pin hole. This boring bar replaced the usual type of fluted reamer which chattered and placed a heavy power demand on the drill-press motor.

Boring bar for cutting tapered side-rod knuckle-pin holes

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

The Purpose of Air Ejectors on Centrifugal-Pump Suction Lines

Q.—What is the purpose of the air ejector on the feedwater-pump suction line of an engine equipped with a centrifugal water pump? How do you know if the ejector is functioning properly?

A.—Air ejectors are used on engines equipped with centrifugal feedwater pumps, when the pump is located ahead of the trailer truck and the pump-suction pipe is raised between the pump and the tank hose to clear the swing of the trailer-truck frame; the pipe is often raised to such a position that the high point in the pipe is above the level of the tank bottom. This raise in the suction line forms an air pocket in the pipe and the air ejector is applied to eliminate air from the suction line. If there were air in the suction line the pump would refuse to work. When air ejectors are omitted a vent pipe is applied, this vent pipe being run up to a height of eighteen inches above the top of the fender.

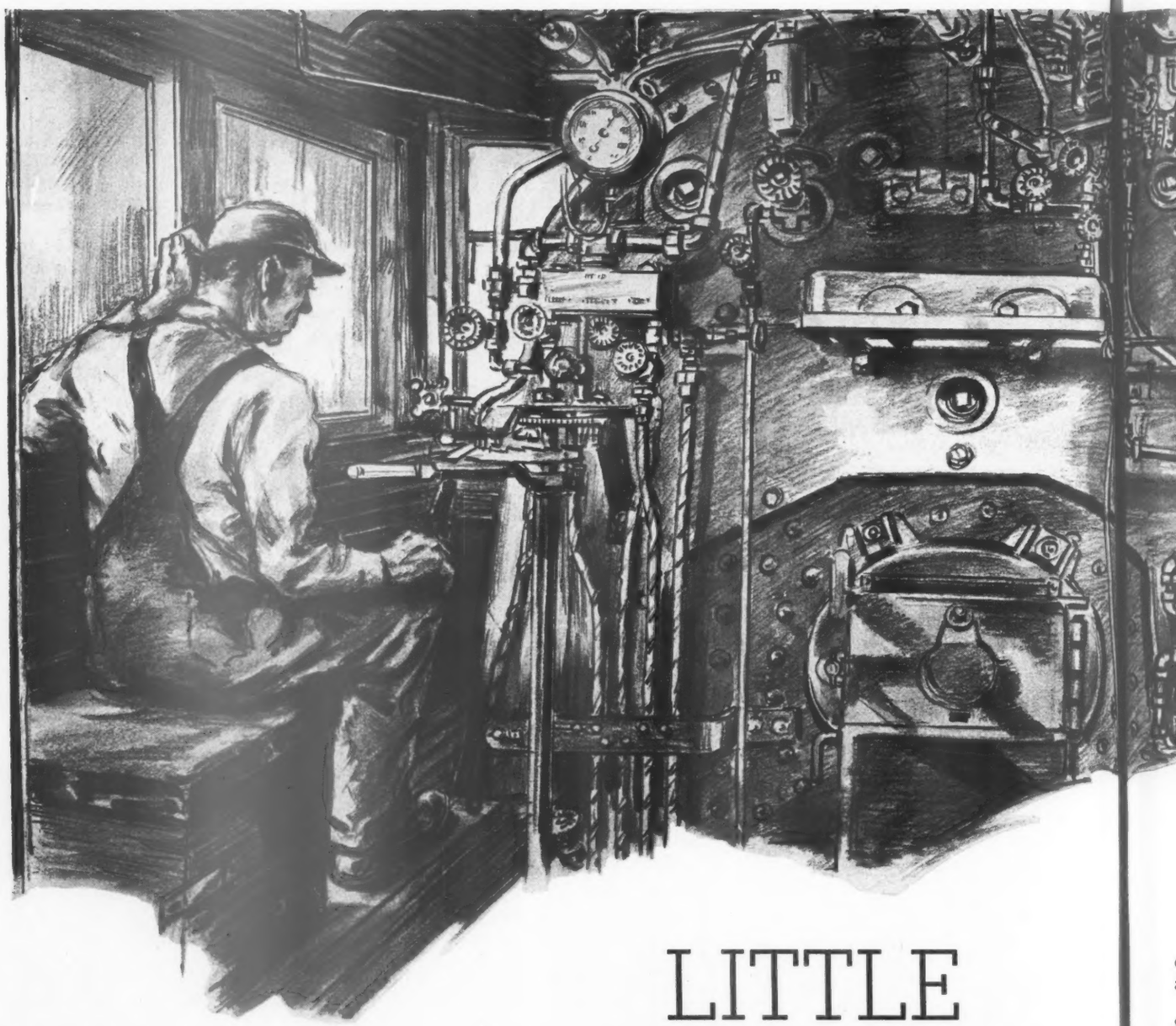
Air ejectors on feedwater-pump suction lines are tested by placing the hand on the high-pressure steam line to the ejector, the ejector, and the ejector discharge line; when the ejector is functioning properly, the steam line will be hot, the ejector will be cold and the discharge line will be warm.

How to Weld Flexible Staybolt Sleeves

Q.—What methods are employed in applying welded flexible staybolt sleeves?—F. C.

A.—The most common method of applying welded sleeves, is to drill and ream the hole in the wrapper sheet so that the sleeve penetrates the sheet ⅛ in. at the center. The sleeve is held tight against the counterbore in the sheet with an applicator and tack welded in

(Continued on page 197)



LITTLE TROUBLE

***by* Walt Wyre**

If Jim Evans was nervous and excitable he wouldn't have been roundhouse foreman at Plainville for the past sixteen years. He would have been wearing his hat crosswise and calling himself Napoleon or on another job long before now.

Evans learned long ago that in railroading what can't be cured must be endured, and a roundhouse foreman must do a lot of both. It's when something happens that should be corrected and no one seems able to find the remedy that makes a foreman wish he was back in overalls working eight hours a day.

Jim Evans doesn't get excited over trifles, but the 5077 came very near making an aspirin addict of the foreman and when the trouble was finally located it was so simple everybody concerned felt as foolish as a fat man who has sat down where he thought a chair was.

One morning about ten o'clock, the dispatcher called the roundhouse office. "The 5077 is falling down awful bad. Better look her over when she gets in, if she makes it," the dispatcher told Evans.

The engine came in over two hours late with seventy-two cars of perishables. Evans was waiting when the engineer ran the locomotive in on the lead. The hog-head climbed down from the cab and started around the engine.

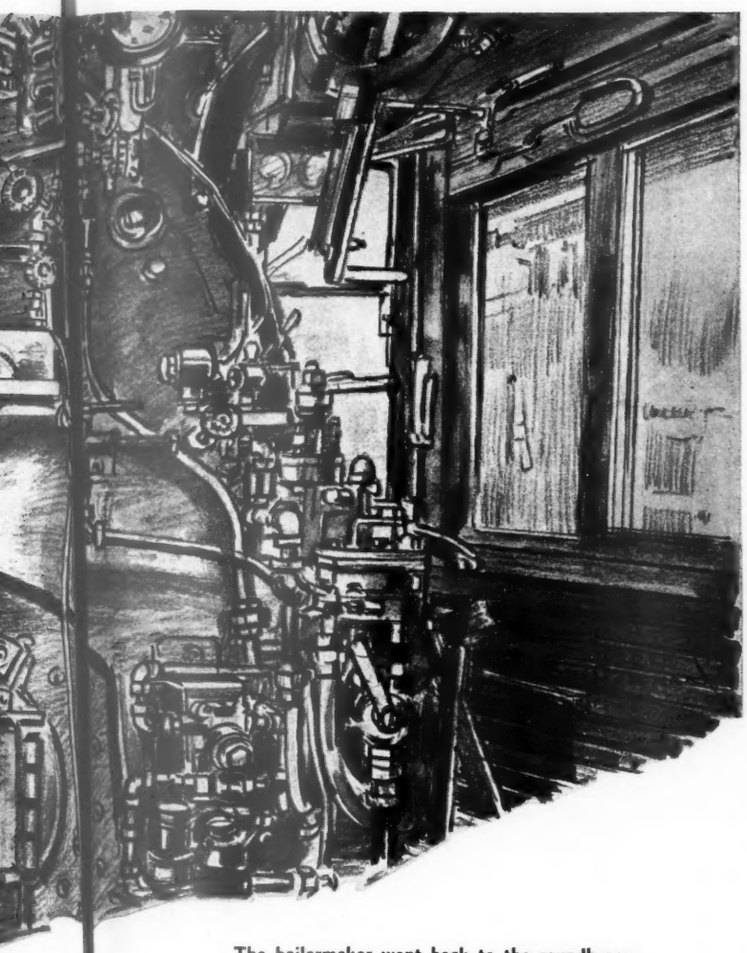
"How did she do? " Evans asked.

"Huh!" the engineer snorted. "It wouldn't pull a sick streetwalker out of a doorway!"

"Couldn't keep steam," the fireman chimed in as he shouldered his tin trunk and started towards the wash-room.

"I thought she was a pretty good engine," Evans said to the engineer.

"Yeah, may have been, but she's no good now," the engineer replied. "Acts like superheater units might be leaking," he added.



The boilermaker went back to the roundhouse. He climbed up in the cab of the 5077 and sat down on the fireman's seat box to ponder over the situation.

When the units were tested with water pressure, three of them showed slight leaks. The units were pulled out and repaired and the 5077 was marked up to run.

The locomotive went out Wednesday morning on No. 81, a fast merchandise train, and finished the run that same week after setting out part of the train. It came back with a light stock train, twenty-eight cars, and the engineer that brought her in said the engine did very well. A train of twenty-eight cars is one thing and one of ninety something else. Running time of forty-five miles an hour with ninety loads takes it out of a locomotive and one that is lacking just can't stand the racket.

"What seems to be ailing the 5077?" Evans asked the engineer that had her out of Plainville.

"Just won't cut the buck," the hogger answered. "Seems O. K. until you have to pour it on her, then she just quits, won't make steam. Could be the piston packing down," the engineer added. "Anyway, she uses steam faster than she makes it."

"Now that's a lot of help," Evans said aloud to no one in particular as he started to the roundhouse.

The foreman found Henry Barton, a boilermaker. Barton was in the fire-box of the 5091 calking a leak. The foreman stuck his head in the fire-box door and yelled to make himself heard above the reverberations of sound in the spacious fire-box. "Say, Barton, did you look over the 5077 before it went out last trip?"

The boilermaker scratched his head and squinted one eye like a man aiming a gun. "Yes, believe I did. Yeah, that's right, I know I did now."

"How did you find her?"

"Oh, not so bad; the channel was pretty well clogged with carbon. My helper cleaned it out, though."

"Did you notice anything else that might keep the engine from steaming?"

"No, nothing except possibly the diaphragm plate is going to have to be renewed soon."

"Was it leaking?" Evans asked.

"Not while standing still," the boiler maker replied, "but I noticed several places that showed it had been leaking. You see, when a locomotive gets to twisting and weaving like they do when they are running, a crack in the diaphragm plate that you wouldn't hardly notice when the engine is standing still sometimes opens up and leaks quite a bit. If you don't mind coming in the fire-box, I'll show you one on this one."

Evans would have climbed stairs to the top of the Empire State building to find a clue to the trouble with the 5077. He wriggled feet first through the fire-box door and followed Barton to the front end of the fire-box.

"See?" The boilermaker held an extension light with one hand and pointed to an irregular white line on the diaphragm plate.

Evans from habit pulled a flashlight from his pocket and directed the beam on the plate where the siphon neck enters the throat sheet. "So that's what you call the diaphragm plate?"

"Yeah, I don't know whether that's the correct name or not, but it's all I ever heard one called except the store department calls them siphon patches. I suppose the reason for calling them 'diaphragm plates' is they are corrugated so they will expand and contract like a diaphragm."

"Don't look like that would give much trouble," Evans said.

"Well, it may not," Barton replied, "but it don't take much leak in this type of fire-box that has a fairly large combustion chamber in the barrel of the boiler to affect steaming."

"Can't you weld the cracks?" the foreman wanted to know.

"Not to do much good. When a diaphragm plate gets checked all over with hairline cracks, the best thing to do is put in a new one."

"Maybe that's what's the matter with the 5077," Evans said hopefully.

"Might be," Barton agreed.

"Let's look at it when it gets cold," Evans suggested as he pocketed his flashlight and started away.

TROUBLE, according to the old adage, never comes single. On the railroad, and particularly in a roundhouse, it seems to come in flocks and breed like guinea pigs.

The 5091 on her last trip in had been reported foaming badly. The boiler needed washing badly, no argument about that, even before the water was tested. The drip from the blow-off cocks looked like whitewash. On short time for a locomotive and with nothing else available, Evans told them to give the 5091 a change of water, some extra compound, and run her.

She came in just ahead of the 5077. The engineer reported that the engine had fallen down badly all the way from Sanford. "The boiler is dirty as a Mae West joke and she hasn't got as much power as a Jewish politician in Germany," the engineer told Evans. "I believe the piston packing is down."

The hoghead was right on all counts. When the en-

gine was in the house, the foreman left orders to have the boiler washed and told a machinist to pull both pistons and examine the packing.

The packing was cut out and the right cylinder was scored a little. Water sloshing over from the foaming boiler had flushed out the lubrication and metal to metal friction did the rest.

In the meantime, the 5077 had been run in the house and blown down. Evans was examining the scored cylinder when Barton came by. "I was going down to look at the diaphragm plate on the 5077," the boilermaker said. "Would you like to take a look at it?"

The two climbed up in the cab and into the fire-box. "The brick look pretty good," Barton commented, playing the beams of his flashlight around the interior of the fire-box.

"Yeah, not bad," Evans said. "Have you looked at the burner?"

Both men, flashlights in hand, walked to the front of the fire-box and stooped to examine the burner.

"Not bad," Barton commented as he stooped lower for a better look. "The atomizer slot is worn a little, but not enough to cause trouble." The boilermaker held the flashlight closer and played the spot of the light beam over the burner.

"Thought maybe it might be cracked on the side," Barton said. "That sometimes causes trouble with an engine steaming."

"Is it cracked?" the foreman asked, hoping to find what defect was causing lack of power in the locomotive.

"No," Barton replied, straightening up, "looks O. K. to me."

"Well, let's look at the diaphragm plate," Evans said resignedly.

"Leaking a little here." Barton traced a white crack with a pointing forefinger.

"And here." Evans found another place.

"What do you think?" Evans asked when he and Barton had finished examining the diaphragm plate.

"Well," Barton said thoughtfully, "it's not bad. I doubt if it's causing the trouble. On the other hand, then it could be. Like I told you, when an engine gets to hittin' the high spots and twistin' all over like a fat girl doin' the Big Apple, it's hard to say just what does happen. But still I don't think that's the trouble with this engine."

"Well, something's wrong and we've got to find out what it is." Evans shoved his hat back on his head and scratched thoughtfully.

"I can put in a new diaphragm plate if you say so," Barton prompted.

"All right, let's put it in and go over everything that might be causing the trouble." Evans climbed out of the fire-box and started to the office.

HE DIDN'T go to the office, though, at least not just then. What changed his mind was he saw the switch engine coming towards the roundhouse. Coupled to the goat was a shiny, newly painted locomotive.

Evans knew before he saw the numbers it was the 2735 out of the back-shop. He was so glad to see the locomotive he could have kissed it. The foreman waited until the 2735 was shoved in on the inspection track and walked out to look it over.

The hostler slid from the cab on an engine nearby and joined the foreman. "She's got new drivers," the hostler noted, pointing at the disc drivers on the locomotive.

"Yes, and they put on a feed water pump and heater," Evans said.

The foreman walked around the locomotive and climbed up in the cab. The hostler followed him slowly.

"Ought to be a good engine now," the hostler said.

"Yeah," Evans agreed, "she's been overhauled from pilot to draw-bar and partly rebuilt. Let's get her shoved in the house and get the rods on. If anybody ever needed a good engine, I need one now."

The 2735 was ready to go next morning. They ran her on the west local to break her in. The road foreman rode the engine and when he came back on her next day reported a good trip.

"How did she steam " Evans asked.

"Seemed to do all right," the road foreman said. "Of course, we just had a light train and weren't trying to break any speed records."

Next day when the dispatcher asked for a locomotive for a west bound drag, Evans gave him the 2735.

About three o'clock in the afternoon the dispatcher called the roundhouse office and asked to speak to Evans.

"Say, what's the matter with all your engines lately? That 2735 on the drag is getting along so slow that hoboes are getting off and walking!"

"Should be a good engine," Evans replied. "Right out of the back shop."

"Well, it acts like it shouldn't have left there," the dispatcher said.

"Maybe it's still a little tight and will do better when it's limbered up," Evans said.

"Hope so," the dispatcher commented, and hung up.

"How's the 5077 coming?" Evans asked Barton the next day after the engine had been tied up for a diaphragm plate.

"Get her finished sometime tomorrow if nothing happens," the boilermaker said.

"Look her over good before she goes out."

"O. K.," the boilermaker replied.

The 2735 did no better on the inbound trip than she had going west. Boxes and pins ran cool, but that was, the engineer explained, because the engine wouldn't pull the train fast enough to run hot. "Just won't steam," the engineer said.

Fortunately for the foreman's peace of mind, the trouble with the 2735 was located with less trouble than he was having with the 5077.

The boilermaker examined everything in the fire-box, then opened the front end. Evans climbed up on the pilot and looked in.

Barton had only been in the smoke box a couple of minutes when he said, "I believe here's the trouble!"

"What is it?" Evans asked.

"Whoever set that feed water heater on top of the smoke box didn't do a very good job. Too much air leak around it."

Evans pulled himself up through the front end door and looked.

The feed water heater was set on top of the smoke box with the lower side of the drum in an opening cut in the top of the smoke box. Whoever did the job in the back shop had evidently been in a hurry, because the drum didn't fit tight in the opening.

"Looks like that might be the trouble," Evans agreed.

"Yeah, that much air getting in would keep it from steaming," the boilermaker said.

The leaks around the feed water heater were repaired and the engine dispatched that night.

Next morning Evans was almost afraid to look at his mail for fear the 2735 had died some place, but there was no wire or traingram about the engine.

Evans, to satisfy his mind, called the dispatcher and asked how the 2735 had done.

"Run like a striped tail ape," the dispatcher said.

Evans was somewhat relieved, but there was still an-

other load on his mind. The 5077 was still in the house. The engine was finished and the foreman was almost afraid to run her.

After the 8:00 whistle blew, Evans found Barton. "What do you think about the 5077?"

"Well, as far as the boiler work is concerned, she looks like a good engine to me."

"How's the front end?" Evans remembered the trouble with the 2735.

"O. K.," Barton replied, "I looked it all over yesterday. There's not any leaks around the nozzle stand. The petticoat pipe is in good shape, right in the center and no holes in it. In fact, everything in the front end looked O. K. to me."

"How's the steam nozzle? Did you measure it?"

"Yeah, it's standard, the same as all the 5000's."

"Well, I guess she should be ready to run. Have a fire put in her." The foreman marked the 5077 up ready to run.

The dispatcher called for an engine to run east on No. 82 at 1:15. Evans gave him the 5077.

It was just another chapter of the same old story. The 5077 just wouldn't do her stuff. The train lost time all the way to Sanford.

WHEN the phone rang about four o'clock, Evans had a premonition, only he called it a hunch, that the 5077 wasn't doing so well. "Say, if all the engines were like the 5077, we could throw away our watches and run trains by the calendar," the dispatcher said sarcastically.

"Not doing so good?" Evans asked.

"Going to have to cut her out at Sanford," the dispatcher said accusingly.

When the 5077 came in on the local the next day, Evans shuddered at the sight of the big locomotive. He resolved then and there to not run the engine again until the trouble was corrected.

The rapidly accumulating file of letters, traingrams, and wires about the engine were enough to remind him in case he forgot.

He called Barton to the office. "I want you to find out what's wrong with the 5077," Evans told the boilermaker. "From what the engineers say, the trouble is it's just not steaming. I've examined pistons and valves. They're in good shape. We tested the units and dry pipe, so it must be combustion. I want you to stay with it until you find the trouble."

The boilermaker went back to the roundhouse. He climbed up in the cab of the 5077 and sat down on the fireman's seat box to ponder over the situation.

Barton was confident that none of the usual troubles was causing the 5077 to not steam. But what was it? As he sat thinking he moved the handle of the firing valve back and forth.

Just before noon the dispatcher called the roundhouse office. "I want an engine for a special at 3:15, a good engine," the dispatcher added.

"What kind of special?" Evans asked.

"Race horses from California. They were going another route and changed to the S. P. & W. The owners are with them and in a hurry. It'll take a 5000."

"I'll call you back," Evans groaned. There wasn't a good 5000 in the house. The only one that should be in condition to go was the 5077.

He decided to look them over, even though he knew the condition of every locomotive in the roundhouse. When the foreman reached the 5077 there was no one around the engine. He went in search of Barton.

"What's the matter? Did you give up on the 5077?" he asked the boilermaker.

"No—finished."

"Hope so," Evans commented fervently. "I've got to have an engine that's in good shape."

"Take the 5077," Barton suggested.

"Reckon it'll run? What did you find?"

"I think it will go. If you don't mind, I'll tell you what I found after it makes a trip."

"I haven't got time for riddles," Evans said, "but I'm going to run the 5077 on a hot-shot special. It had better go!"

About five o'clock, Evans called the dispatcher and asked how the 5077 was doing.

"Running like a bat out of hell!" the dispatcher said.

Evans went to the roundhouse and found Barton. "What did you do to the 5077? She runs like a new engine."

"Well, after looking over all the big things I decided to look at the little ones. The handle on the firing valve had slipped on the shaft and it didn't open the oil valve wide open. I don't see why some one didn't notice it before," Barton added.

"Neither do I. It would have saved me a lot of trouble if they had."

Locomotive Boiler Questions and Answers

(*Continued from page 193*)

place. The applicator is then removed and the sleeve welded all around.

The applicator is made of a round bar of suitable length and threaded at one end to suit the tapped staybolt hole in the crown sheet. A handle is secured to the opposite end for engaging the applicator in the crown sheet and a washer, the outside diameter of which is threaded to engage the staybolt-cap threads of the sleeve, is free to move along the applicator. The body of the applicator is threaded and a hand screw is applied thereon. The use of the sleeve applicator assures the correct alinement of the sleeve and bolt and at the same time holds the sleeve securely in the counterbored seat in the plate.

Sleeves are also applied without the use of an applicator by applying the bolt and sleeve together, drawing the bolt down in the sleeve; the bolt holds the sleeve in the counterbored seat in the wrapper sheet. With this method all bolts and sleeves are applied, the face of the sleeves lined up with the wrapper sheet and the sleeves then welded all around.

How Do Steam Dryers Function And Why Are They Used?

Q.—Why are steam dryers used on locomotive boilers and how do they function?—B. J. B.

A.—Steam dryers are used on locomotive boilers to separate the water from the steam before it passes to the superheater. Due to the high water level carried on modern boilers, which generally have low domes, the steam is saturated with water when passing into the bootleg or dome throttle. Tests have shown that for each per cent of water, by weight, that is carried over into the superheater with the steam, there is a drop of about 17 deg. in superheater. In large locomotives the carry-over of moisture into the superheater is from 5 to 10 per cent.

The steam dryer is usually located in the dome and takes the place of the conventional bootleg at the end of the dry pipe. Some types of dryers are incorporated

as part of the throttle valve. There are various makes of steam dryers on the market, each using its own principle of removing the water from the steam. One method is to enter the steam into the dryer, which consists of fixed turbine-shaped vanes arranged within the body of the dryer, causing the entering steam to be whirled around at high velocity with the result that the water is centrifugally separated against the sides, ejected through the outlets, and returned to the boiler.

Another method is to enter the steam into the dryer through circumferential radial slots in the outer wall of a cylindrical shape dryer, the slots being so shaped as to divert the direction of the steam. The steam is then passed through another series of radial slots in a second cylindrical wall, abruptly changing the direction of the steam flow; the steam then passes into a third chamber through protruding cone-shaped nozzles in the outside wall of the inside chamber. These successive actions produce powerful tangential and turbulent impact and inertia effects that separate the water from the steam.

When to Test Staybolts

Q.—Should the staybolts of a locomotive boiler be hammer tested when the boiler is empty or when under pressure?—H. V. D.

A.—Either method is acceptable; however, there are certain circumstances which determine whether the test shall be made with the boiler under pressure or with the boiler empty.

The Master Boiler Makers' Association recommends that it is practical to hammer test staybolts while the boiler is under hydrostatic or air pressure. However, this cannot be successfully done at monthly inspections in enginehouses or when the engine is undergoing classified repairs; therefore, it is recommended that staybolts be hammer tested under these conditions with the boiler empty. In the enginehouse, the test should be made just as soon as the boiler is empty of the hot water and while the firebox is somewhat expanded. In the backshop, when the engine is undergoing classified repairs, the staybolts should be hammer tested and inspected from the interior of the boiler, and all defective bolts renewed, when repairs to the boiler are completed and hydrostatic pressure applied. All staybolts should be hammer tested again while the boiler is under pressure.

Provisions for staybolt testing, as given in the I. C. C. laws, rules and instructions for inspection and testing of steam locomotives and tenders and their appurtenances, are as follows:

"21. *Time of testing rigid bolts*—All staybolts shall be tested at least once each month. Staybolts shall also be tested immediately after every hydrostatic test.

"22. *Method of testing rigid bolts*—The inspector must tap each bolt and determine the broken bolts from the sound or the vibration of the sheet. If staybolt tests are made when the boiler is filled with water, there must be not less than 50 lb. pressure on the boiler. Should the boiler not be under pressure, the test may be made after draining all the water from the boiler, in which case the vibration of the sheet will indicate any unsoundness. The latter test is preferable.

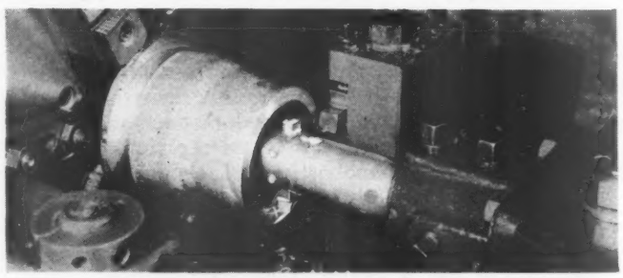
"23. *Method of testing flexible staybolts with caps*—Except as provided in paragraph (b) all staybolts having caps over the outer ends, shall have the caps removed at least once every two years and the bolts and sleeves examined for breakage. Each time the hydrostatic test is applied the hammer test required by rules 21 and 22 shall be made while the boiler is under hydrostatic pressure not less than the allowed working pressure.

"(b) When all flexible staybolts with which any boiler is equipped are provided with a telltale hole not less than $\frac{5}{16}$ in. nor more than $\frac{7}{32}$ in. in diameter, extending the entire length of the bolt and into the head not less than one-third of its diameter, and these holes are protected from becoming closed by rust and corrosion by copper plating or other approved method, and are opened and tested each time the hydrostatic test is applied, with an electrical or other instrument approved by the Bureau of Locomotive Inspection, that will positively indicate when the telltale holes are open their entire length, the caps will not be required to be removed. When this test is completed, the hydrostatic test must be applied and all staybolts removed which show leakage through the telltale hole.

"The inner ends of the telltale holes must be kept closed with a fire-proof porous material that will exclude foreign matter and permit leakage of steam or water, if the bolt is broken or fractured, into the telltale hole. When this test is completed the ends of the telltale holes shall be closed with material of different color than that removed and a record kept of colors used."

Cobalt-Chromium-Tungsten Alloy Cutting Tools

Haynes Stellite Company, Kokomo, Ind., is now offering a cobalt-chromium-tungsten alloy for metal-cutting tools. The alloy, which is known as Haynes Stellite-2400, was designed to provide greater edge strength, operate with economical tool life at even higher speeds than Haynes Stellite J-metal, with no reduction of feeds and depths of cut. These alloy cutting tools are marketed in a variety of sizes of solid square and rectangular tool



Rough and finish facing, and boring high-chromium steel with a Haynes Stellite-2400 tool bit

bits, welded-tip tools, milling cutter blades, and special small tools to suit requirements. This alloy is said to have shown marked superiority over tools previously used, including J-metal, and has proved suitable and economical for roughing and finishing cast and forged steels; nitrided, stainless, and other alloy steels; cast iron and malleable iron. Speeds and feeds recommended for its use are from 10 to 50 per cent in excess of those at which J-metal is now being operated.

Haynes Stellite-2400 can be ground either by hand or by machine. While cutting, edges should be supported as much as possible, depending upon the operation. The strength of the alloy is such that, in some cases, allowable clearance angles are as great as those used with high-speed steel tools. It is not possible to give definite cutting or clearance angles, as every job must be treated individually to determine the best operating conditions.

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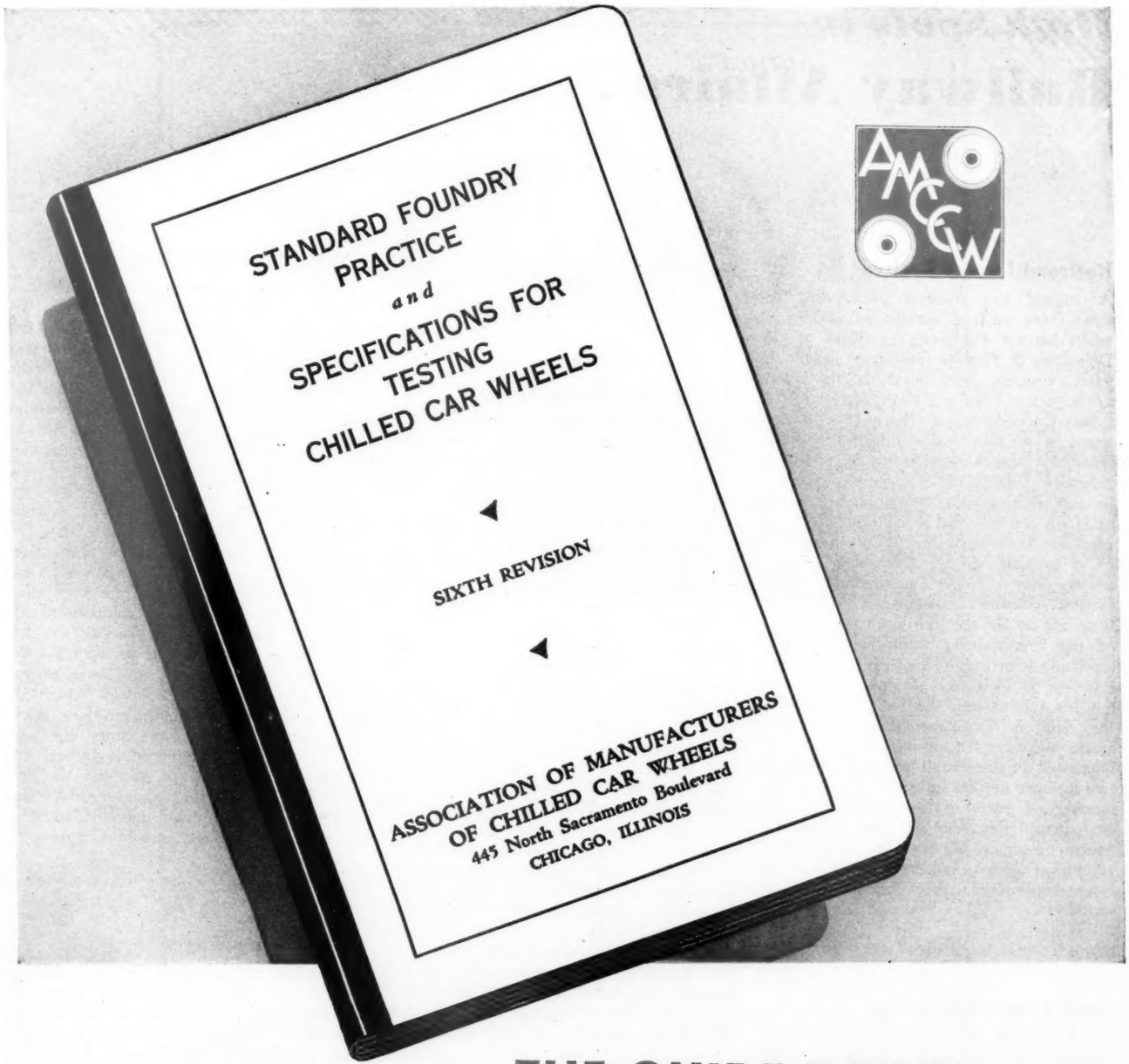

THE GUIDE BOOK of an INDUSTRY

The fundamental basis of any properly organized inspection system is a standard set of stringent manufacturing specifications carefully covering the processes of manufacture, fixing definite limitations and tolerances and requiring instrumental control and tests necessary to prove the required quality of the product.

The A. M. C. C. W. specifications are so written. Furthermore, they are always subject to revision and further restrictions as new and improved processes are developed by our well-organized RESEARCH DEPARTMENT in the course of our efforts to make "Every Wheel As Good As The Best."

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High Spots in
Railway Affairs . . .

Railroad Leader Retires

A rugged and colorful personality retired from railroad service on March 31, when Leonor F. Loree, president of the Delaware & Hudson for very nearly 31 years, resigned because of failing health as he neared his eightieth birthday. A thinker, a fighter, and thoroughly experienced in practical railroading, he made an unusually large contribution to economic progress. Trained as a civil engineer he slipped over into the operating department in which he advanced rapidly. President for three years of the Baltimore & Ohio, and then of the Rock Island Company, he became president of the D. & H. in 1907. Almost coincidentally with his long D. & H. service, he was chairman of the Kansas City Southern. Railroad mechanical men appreciate his keen understanding of their technical problems. Under his sponsorship the D. & H. has led the field in experimentation with high steam pressures locomotive boilers. Greatly interested in the simplification of locomotive and car design, he could tell the exact number of parts in the latest D. & H. equipment. Regarded by some as an opponent of organized labor, he went far beyond most railroad officers in attempting to insure continuity of employment and social security.

Train Limit Bill Buried

On March 31 the House Committee on Interstate and Foreign Commerce, after long and extensive hearings, voted 14 to 7 against reporting the bill to limit freight trains to 70 cars. It will be recalled that the railroad world rubbed its eyes in amazement on July 26, 1937, when the United States Senate, without having held any hearings by its Interstate Commerce Committee, unexpectedly passed the bill without a record vote. In the hearings recently held by the House Committee, railroad labor representatives argued that the shorter trains could be operated with greater safety and would develop more traffic; they soft pedaled on the "make work" argument. Railroad managements, on the other hand, insisted that fewer trains of longer length could be operated with greater safety and far more economically. Reduction to a maximum of 70 cars would demoralize freight traffic and increase the annual operating costs by $100,000,000 and would require additional capital expenditures of one-half billion dollars for rearrangement of facilities. Moreover, several billions of dollars invested in recent years to make possible the safe and expeditious handling of the longer trains, would be practically wasted.

I. C. C. In Wrong Again

Continued poor business conditions and the resulting low freight car loadings, on top of the action of the Interstate Commerce Commission in granting only a small part of the freight rate increase requested, have placed the railroads in a most hazardous position. Denial of the passenger fare increase on the eastern railroads has not simplified the situation. The Interstate Commerce Commission is being widely criticized for overstepping its bounds and usurping managerial functions; indeed, this was even emphasized in one of the dissenting opinions of an Interstate Commerce Commissioner in the eastern passenger rate decision. President Roosevelt himself, in his message to Congress, suggested that the Interstate Commerce Commission's "purely executive" powers "are in all probability unconstitutional." "It would seem," he said, "to be part of common sense to place all executive functions relating to all transportation in one federal department—such as the Department of Commerce, the Department of the Interior, or some other old or new department. At the same time all quasi-judicial and quasi-legislative matters relating to all transportation could properly be placed under an independent commission—a reorganized I. C. C. And such action would be highly constitutional."

The President Side Steps

Considering the widespread publicity given to the fact that the President was holding conferences on the railroad question with various interested parties, and the fact that a railroad committee, consisting of Interstate Commerce Commission Chairman Splawn and Commissioners Eastman and Mahaffie, rushed their report to him at Warm Springs, considerable surprise was expressed at the fact that he merely bundled up the committee's report with various comments from different people and passed it on to Congress on April 11, with no recommendations and a statement that, "Until it has been possible for the Congress to make any and all studies for a permanent solution of the railroad problem, some immediate legislation is, I believe, necessary at this session, in order to prevent serious financial and operating difficulties between now and the convening of the next Congress."

Must Face the Music

Critics have accused railway officials of whining when they have pleaded their case for relief from unfair competitive conditions and regulation. The Administration and Congress have had so many other pressing problems on their hands that they have practically marked time in considering the railroad situation, or, as in the case of the Interstate Commerce Commission, have turned a deaf ear to the necessities of the carriers. The "recession," however, has put the "fat in the fire" and something must be done! What it will be is not apparent as we go to press. The Congressional leaders are calling conferences and the railway executives are very much on the jump trying to find solutions to take care of the immediate necessities. Any long time measures are so controversial that only slow progress may be expected, with all the other troubles in which the nation finds itself. Such immediate remedial suggestions as have thus far been made by those in high governmental and political positions are picayune. They must "face the music," however, and action must be taken without delay if anything is to be done by the present Congress.

Concerning Wages

Following a conference between railway executives and labor leaders after the President sent his message on the railroad emergency to Congress, George M. Harrison, president of the Railway Labor Executives Association, stated: "The carriers asked us to discuss a wage reduction and we replied, 'Hell, you are not going to get anything out of us'. We won't give them the whiskers from yesterday's shave." J. J. Pelley, president of the Association of American Railroads, after the refusal of the labor leaders to consider a voluntary wage cut said, "There is just one thing about it. We have got to have more for what we do and pay less for what is done for us. A reduction of wages is necessary. If the labor unions would talk about a voluntary reduction it would only be until times get better. If we are forced to use the Labor Act machinery, we will formally request a reduction." What would the public think, if in the argument on wages, the actual facts were blazoned forth as to the gross injustice to the railroads and the public of some of the wage rules of the engine and train service employees? Is there any better time for a frank discussion of these facts?

(Turn to next left-hand page)

STEAM

will provide any train speed you can use

Modern Super-Power Steam locomotives remove the limitation of speed due to motive power, and safely permit any train speed made possible by other operating characteristics.

With high speed the steam locomotive also combines flexibility of safe train operation, comfort, and low cost.

Without introducing any unproved elements the Super-Power Steam locomotive alone provides all requirements of high speed passenger service.

LIMA LOCOMOTIVE WORKS — LIMA LOCOMOTIVE WORKS INCORPORATED — INCORPORATED, LIMA, OHIO

NEWS

Equipment Repair Programs

The Chicago Great Western has placed an order with the Pullman-Standard Car Manufacturing Company for repairs to 27 box and automobile cars.

The Lehigh Valley has received permission from the Interstate Commerce Commission to borrow $778,000 for repairs to equipment, including 1,460 steel coal cars.

Shop Improvements

Chicago & North Western.—The Chicago & North Western will restore its shops at South Pekin, Ill., which were destroyed by the tornado that swept through this vicinity on March 30. Damage to the shops and other property of the railroad is estimated at $100,000.

Western Pacific.—A contract for the construction of an extension to this company's locomotive repair shop at its general shops at Sacramento, Cal., has been awarded to Fred J. Early, Jr., San Francisco, Cal. The new building, of steel and concrete, will be 150 ft. by 300 ft., and is part of a project for the improvement of the general shops which calls for an expenditure this year of approximately $460,000.

Century Schedule to be Reduced One-Half Hour

A REDUCTION of 30 min. in the schedule of the Twentieth Century Limited of the New York Central, operating between Chicago and New York, will be made on June 15, when new streamline steam-operated trains will be placed in service.

Because the new Century, an all-room train, will carry no Boston service, a new train, to be known as the "New England States" will be inaugurated between Chicago & Boston on June 15. It will be an all-Pullman train of standard Pullman equipment with sections, bedrooms, compartments, drawing-rooms and lounge facilities.

Testing Laboratory Named After Prof. Talbot

ON April 21 the Materials Testing Laboratory at the University of Illinois, Urbana, Ill., became known as the Arthur Newell Talbot Laboratory, in honor of Arthur N. Talbot, professor emeritus of the university, who is widely known in the railroad field for his investigations of various railroad engineering problems, particularly stresses in track. This new honor was conferred on Prof. Talbot "for those brilliantly active years as a teacher and investigator which have contributed so much to the University of Illinois and to the engineering profession."

"Men Make Steel"

A NEW four-reel film of steel making, in technicolor and sound, was shown at a preview at the Waldorf-Astoria Hotel, New York, on April 13 by the United States Steel Corporation. It is entitled "Steel—Man's Servant." The color film, which strikingly brings out the spectacular quality of steel-mill operations, carries the story from the open-pit mines on the Missabe Range, down the Great Lakes to the ore-unloading docks, and thence through the operations of steel making and the production of the various finished products of the industry. A one-reel version in technicolor was also shown at the preview. This carries the audience over the same ground as the longer film, but with the pictures confined to the more dramatic phases of the operations. Both films deal with the human factor in the making of steel as well as with the spectacular mechanical operations.

The films were produced by Roland Reed Productions which maintained a movie crew of 21 photographers, technicians and electricians on location for a 10-weeks' period. The R. C. A. sound system was used. The story accompanying the pictures is told by Edwin C. Hill. The musical score was recorded under the direction of Robert Armbruster, Vittorio Giannini being the musical consultant.

Both films are intended for educational and entertainment purposes. A considerable demand for the longer film has already developed in the moving picture houses of steel-mill towns. The United States Steel Corporation has also produced 16 mm. black-and-white films which deal at greater length with the technique of the various operations. These are intended for use in schools and colleges.

Broadway, Carrying New Cars, to Make Sixteen-Hour Run

THE Pennsylvania's Broadway Limited, carrying new equipment, will run between New York and Chicago in 16 hours, effective June 15, reducing the New York-Chicago schedule by 30 minutes in both directions. The newly designed Pullman cars, the features of which were announced by the road in the Spring of 1937, are now being turned out of the Pullman shops in Chicago. All sleeping cars of the new Broadway will be exclusively of the private room type.

The new equipment was designed jointly by engineers of the railroad and the Pullman Company, in collaboration with Raymond Loewy, industrial designer. The new cars will be placed not only on the Broadway but will also be used to re-equip partially the east and west bound General

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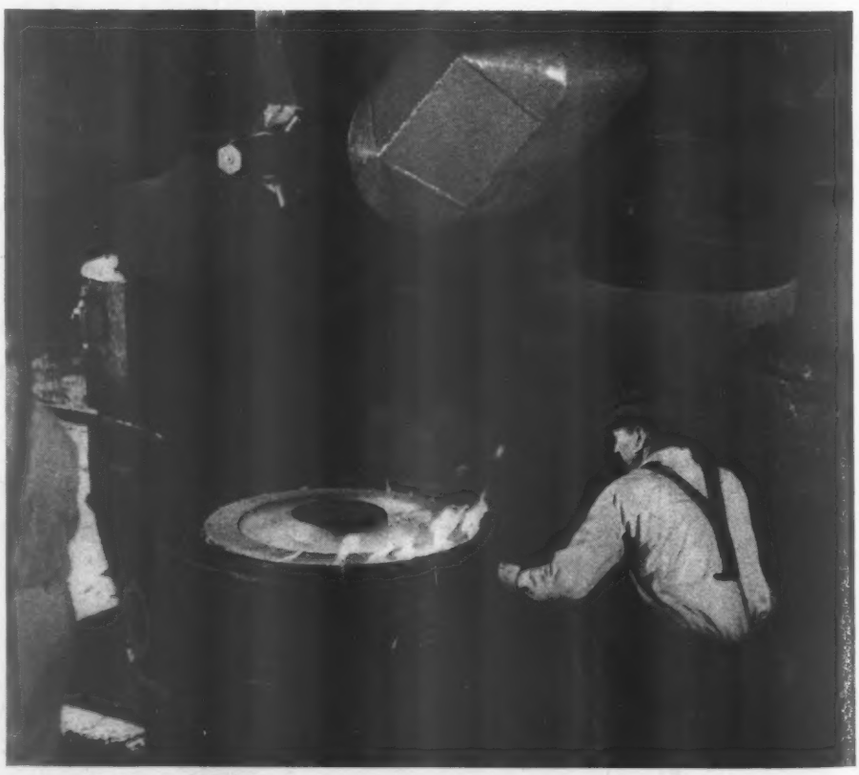


A scene from "Men Make Steel"—A wheel formed in a 10,000-ton hydraulic press

THREE CONDITIONS

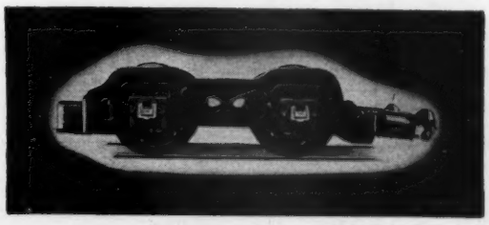
that modern locomotives must meet

1 A lower driving wheel load limit to suit high speed operation in relation to track.

2 High power output to pull the train at present-day speeds.

3 Limitation of starting power by the factor of adhesion.

These considerations have brought a new approach to the design of high-speed passenger locomotives. » » » The cylinders, pressure and driving wheels have been proportioned for the work to be done at the road speeds, using as few drivers as practical. » » » Leading and trailing trucks carry the remainder of the locomotive structure. » » » To restore the design to a proper balance, the deficiency in starting power is supplied by using The Locomotive Booster to put idle trailer weight to work. » » » This insures minimum number of driving axles and minimum weight on drivers, resulting in a locomotive that is easier on track. » » »



Franklin parts fit — in applying them there is no labor cost for fitting. They are built to original dimensions of carefully selected materials — they avoid road failures and excessive maintenance.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

between New York and Chicago; the Liberty Limited between Washington, D. C., and Chicago; and the Spirit of St. Louis, between New York and St. Louis, Mo.

Upward Trend of Fuel Costs Shown in Study

THE continued decrease in unit fuel consumption and increase in unit fuel costs is clearly indicated in the accompanying table which has been developed by the Railway Fuel & Traveling Engineers' Association, from data issued currently by the Interstate Commerce Commission, Bureau of Statistics. Fuel figures for January and February, 1938, and a comparison with February, 1937, are given in the table.

Fuel Performances and Costs in Freight and Passenger Road Service, Class I Railways

	January, 1938	February, 1938	February, 1937	Per cent increase or decrease, 1938, compared with 1937
Coal per 1,000 gross ton-miles, lb. ... (including locomotive and tender)	127.0	125.0	130.0	−3.84
Fuel cost per 1,000 gross ton-miles, cents ..... (including locomotive and tender)	18.05	17.77	16.89	+5.21
Coal per passenger-train car-mile, lb.	16.1	15.9	16.4	−3.05
Fuel cost per passenger-train car-mile, cents	2.28	2.26	2.15	+5.12
Average cost of fuel per equated net ton (coal equivalent)	$2.84	$2.85	$2.62	+8.78

With gross ton mileage for February, 1938, reduced 22.2 per cent below February, 1937, values, passenger-train car mileage reduced about 2.5 per cent and better unit fuel performance this year in both classes of service, the total cost of fuel and power consumed by the Class I railways at $19,840,000 was only 13.6 per cent lower than in February, 1937, because of the increase of 8.78 per cent in the price per equated net ton (coal equivalent). Curtailment of the volume of business has occurred principally in the commodities that permit slower movement in heavier trains, and has been accompanied generally by the reduced average engine loads resulting from the movement of a greater proportion of light commodities at higher speed.

The improvement in the unit consumption of fuel, notwithstanding the handicap of the drastic reduction in the volume of traffic and the change in its character, must be considered a creditable development.

Arch-Bar Cars Will Earn Rentals Until July 1 Deadline

THE Association of American Railroads on March 31 issued a ruling whereby freight cars equipped with arch-bar trucks will continue to earn regular per diem and mileage payments until July 1, the effective date of the order prohibiting the use of such cars in interchange service. When the A. A. R. last November extended the deadline from January 1 to July 1 it also provided that "after April 1, 1938, mileage or per diem shall not be paid car owners for cars equipped with arch-bar trucks."

The March 31 ruling lifts the latter proviso; the July 1 deadline remains unchanged. Meanwhile the supplement to the mileage tariff which proposed to cut off payments on April 1 has been withdrawn.

Data on the arch-bar truck situation given in the latest annual report of Director W. J. Patterson of the Interstate Commerce Commission's Bureau of Safety, estimated that, had the order become effective on January 1, the number of cars temporarily prohibited in interchange in the U. S. would have been "less than 150,000."

No Mechanical or P. & S. Meetings This Year

DECISIONS have been reached by the general committees of the Mechanical Division and the Purchases and Stores Division, A. A. R., to hold no annual meetings this year. Business conditions and necessity for the railroads and the A. A. R. to curtail expenses to the greatest possible extent are given as the reasons for the action. Committee reports containing definite recommendations will be considered by the general committee of each division and reports requiring further action will be subject to letter ballot vote and formal approval by each division at its next annual meeting.

New Equipment Orders and Inquiries Announced Since the Closing of the April Issue

LOCOMOTIVE ORDERS

Company	No. of locos.	Type of loco.	Builder
Canadian Pacific	10*	2-10-4	Montreal Loco. Wks.
Chilean State Railways.....	7	4-8-2	Baldwin Loco. Wks.
Southwest Missouri	2	30-ton gasoline †	Plymouth Loco. Wks.
Warrior River Terminal.....	1	900-hp.	American Loco. Wks.

FREIGHT-CAR ORDERS

Road	No. of cars	Type of car	Builder
Mathieson Alkali Works, Inc....	3	50-ton transport	American Car and Foundry Co.

FREIGHT-CAR INQUIRIES

General Chemical Co.....	7–10	70-ton covered hopper	.....
Mathieson Alkali Works, Inc....	3–5	40-ton tank	.....
Pittsburgh Plate Glass Company	1	10,000-gal. tank	.....
Southern Railway	3,000	40-ton box	.....
	250	40-ton stock	.....
	200	50-ton furniture	.....
	1,000	50-ton D. B. gondola	.....
	500	50-ton gondola	.....
	25	70-ton gondola	.....
	25	70-ton flat	.....

PASSENGER-CAR ORDERS

Road	No. of cars	Type of car	Builder
Pullman	1	Sleeper ‡	Pullman-Std. Car Mfg. Co.

PASSENGER-CAR INQUIRIES

Southern	§	.....	.....

* T-1-b class. These locomotives are for service on passenger trains between Calgary, Alta., and Revelstoke, B. C. They will be semi-streamline and will use oil as fuel. They are in addition to the orders for 25 locomotives reported in the April issue.

† Mechanical drive. One of these locomotives is to be placed in service between Webb City, Mo., and the Prosperity and Duenweg areas and one between Baxter Springs and Picher.

‡ Roomette Car No. 2; to contain 18 rooms.

§ Purchase of four Diesel-electric passenger units contemplated. Type of car not yet definitely determined.

Supply Trade Notes

F. B. ERNST, vice-president of the American Steel Foundries, Chicago, has been elected a director.

◆

HERBERT H. MOFFITT, Hill building, Washington, D. C., has been appointed southern district manager for The Rails Company, New Haven, Conn.

◆

IRON & STEEL PRODUCTS, INC., Chicago, has discontinued its New York sales office, and will handle business in that territory from Chicago.

THE J. G. BRILL COMPANY has moved its St. Louis, Mo., office from 1558 South Vandeventer avenue to 705 Olive street. This office is in charge of R. S. Hood, Jr., district sales manager.

◆

THE COLUMBIA MACHINE TOOL COMPANY, Hamilton, Ohio, has purchased all the Long & Allstatter records, drawings, blue prints and patterns, and is prepared to furnish new improved design plate and structural steel machinery such as punches, shears, etc.

J. S. GAMMEL, eastern railway sales representative of the National Carbon Company, Inc., has been transferred to the general sales department of the Evertional Carbon Company, Inc., with headquarters at New York.

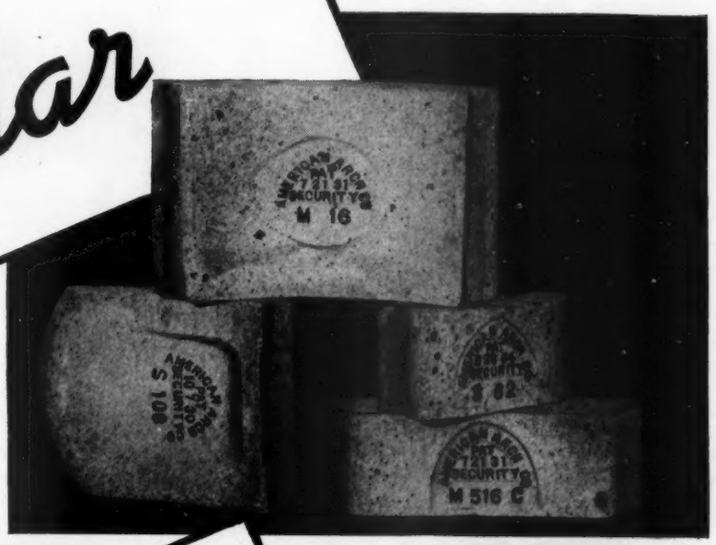
◆

A. J. ERLACHER has been appointed district manager of the J. G. Brill Company, in charge of a newly created sales territory comprising Maryland, Pennsylvania and southern New Jersey. Mr. Erlacher's

(*Turn to next left-hand page*)

WOULD YOU SPEND...

1 dollar



TO SAVE...

10 dollars

You accept locomotive arches as a matter of course; as a fundamental in locomotive design. But the Arch can only give you the full economy when each course and each arch brick is in place. Paring down the arch in an effort to save $1.00 costs you $10.00 for the extra fuel wasted by the shortened arch.

These proportions have been established by repeated tests on various types of motive power. So against any "saving" in arch brick expense by cutting down the arch, mark up $10.00 on the loss side of the ledger.

There's More To SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists

AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

headquarters are at Philadelphia. W. M. Horsell, district manager at Philadelphia, retains the sales territory comprising Metropolitan Philadelphia, Chester, Pa., Washington, D. C., Baltimore, Md., and the states of Delaware and Virginia.

◆

ALLEN W. MORTON has been elected a vice-president of the Koppers Company. Mr. Morton will continue in charge of Koppers' American Hammered Piston Ring Division, at Baltimore, Md., where he has been general manager.

◆

MOXIE S. GEORGE, assistant district sales manager of the Inland Steel Company, with headquarters at Milwaukee, Wis., has been appointed assistant manager of sales of the flat rolled steel division, with headquarters at Chicago.

◆

D. J. CROWLEY, formerly special representative of Hubbard & Company, Pittsburgh, Pa., with headquarters at Chicago, has organized the Universal Spring Washer & Supply Company, 6 North Michigan avenue, Chicago, to manufacture and sell the Universal spring washer, heretofore sold by Hubbard & Company.

◆

THE ALLOYS DEVELOPMENT CORPORATION of New York, with offices in the International Building, Rockefeller Center, New York, has been formed as a successor to the U. S. Rustless Steel & Iron Corporation. Frederick D. Foote and Dr. Beram D. Saklatwalla are associated in this enterprise. Mr. Foote, as president of the new corporation, will devote his entire time to the development and promotion of the low-cost, weight-saving steels whose use he initiated while railroad industry executive in the commercial office of the United States Steel Corporation. The association of these two men brings together the metallurgist whose work with chromium-copper steels pointed the way to Cor-Ten, a product developed by United States Steel Corporation research, and the commercial executive of that corporation who early recognized the important role which this steel and others of its kind seemed destined to play in industry.

The Alloys Development Corporation holds patents in many steel-producing countries, controlling a number of low chromium-copper alloys. It will be the aim of the newly organized corporation to develop and promote new materials for industrial and structural uses throughout the world. Other members of the board of directors include Edwin Hodge, Jr., president of the Pittsburgh Forgings Company, and Carl W. Ehni, vice-president of the Peoples-Pittsburgh Trust Company, both of Pittsburgh, Pa.

Frederick D. Foote was born in Flint, Mich., and began his business career in the inspection department of the Buick Motor Company. A year later, in 1908, he was appointed chief inspector of one of the plants of the Weston Mott Company, maker of front and rear automobile axles, since acquired by the General Motors Corporation. In 1911 he went to Detroit to engage in home designing and construction, but shortly thereafter became associated with the Greenville Steel Car Company of Greenville, Pa., at that time a maker of front and rear automobile axles. He served successively with this

F. D. Foote

company as purchasing agent, secretary and treasurer, and president. His contact with the railway equipment industry started when the Greenville Steel Car Company became interested in the repair and building of steel freight cars. This company became a subsidiary of the Pittsburgh Forgings Company in 1930, and Mr. Foote was elected president of the latter company in April, 1932. In 1933 he went with the United States Steel Corporation.

Dr. B. D. Saklatwalla was born in Bombay, India, in July, 1881. He studied at the University of Bombay, obtaining the degree of bachelor of science in chemistry in 1901. Later he attended the University of Berlin, in Germany, and the Royal Polytechnicum at Charlottenburg, from the latter of which he obtained the degree of chemical and metallurgical engineer in 1906. He was awarded the degree of doctor of engineering in 1908. In 1907 he was elected a Carnegie research scholar

Dr. Beram D. Saklatwalla

by the Iron and Steel Institute of Great Britain and awarded a grant for conducting research on the effect of phosphorus in steel. In 1908 Doctor Saklatwalla left Germany for the United States and in 1909 became associated with the American Vanadium Company, developing the alumino-thermic reduction process and later the electro-thermic reduction process for the smelting of vanadium ores. He became general superintendent of the American Vanadium Company and occupied the same position with its successor, the Vanadium Corporation of America, advancing to the position of senior vice-president and director of this corporation, which he filled until October, 1935, when he formed the U. S. Rustless Steel & Iron Corporation. In 1924 Dr. Saklatwalla was awarded the Grasselli Medal by the Society of Chemical Industry for his research work in chromium-copper corrosion-resisting steels.

◆

CHARLES L. BROWN, western sales manager of the Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., New York, has retired at his own request, after 32 years of service. Mr. Brown began work with Manning, Maxwell & Moore in Chicago, on July 1, 1906, as the company's only representative for the west and mid-west. Under his guidance, a sales organization was developed for this section and he became western sales manager. Robert Watson succeeds Mr. Brown as western sales manager of the Locomotive Equipment Division, with office in the Field building, Chicago. Mr. Watson was formerly with the Waugh Equipment Company, the Erie Railroad and the American Locomotive Company.

◆

THE AMERICAN CAR AND FOUNDRY COMPANY has moved its St. Louis, Mo., office from 1558 South Vandeventer avenue to 705 Olive street.

◆

THE TRANE COMPANY, La Crosse, Wis., manufacturers of heating, cooling and air-conditioning equipment, have leased space at Bush terminal in New York City for warehousing and assembly facilities, which will be under the management of the Trane New York office, 250 East 43rd street.

◆

JOHN S. LEMLEY, vice-president and a director of the T-Z Railway Equipment Company, Chicago, and the Morris B. Brewster Company, Chicago, with headquarters at St. Louis, Mo., has resigned following the sale of his interest in both companies and will engage in the sale of railway supplies at St. Louis. He entered the railway supply business in 1915 in association with George F. Cotter of Houston, Tex. In 1920 he became associated with the Charles R. Long Paint Company, Louisville, Ky., and the Viloco Railway Equipment Company and the Okadee Company, of Chicago. Following the sale of his interest in these companies he purchased an interest in the T-Z Railway Equipment Company and the Morris B. Brewster Company on January 1, 1930. Mr. Lemley is a co-inventor of several products used by railroads.

◆

THE UNITED STATES STEEL CORPORATION, at a meeting of its board on April 5 elected Edward R. Stettinius, Jr., as chairman of the board, succeeding Myron C. Taylor, and Mr. Stettinius retired from the chairmanship of the finance committee. Edward M. Voorhees retired as vice-chair-

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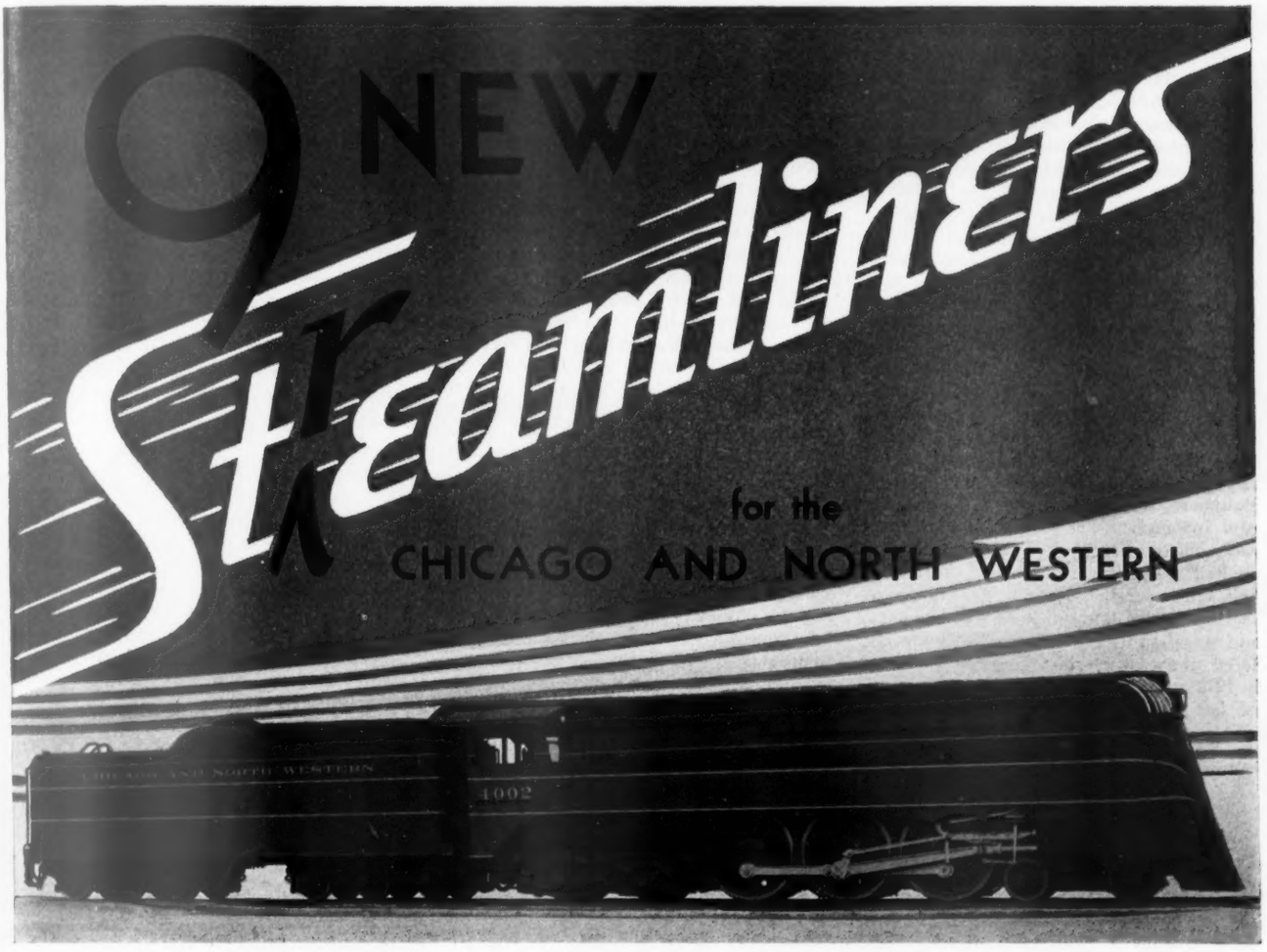

NINE new streamlined locomotives of the 4-6-4 type have been completed for the Chicago and North Western to speed up the heavy passenger trains between Chicago and Omaha. The trains in this service, usually consisting of 14 to 16 cars, have outgrown the capacities of the existing 4-6-2 engines which previously hauled them.

The new streamlined locomotives, attractively sheathed and painted to harmonize with the new cars also operating in this service, develop maximum possible power obtainable with three driving axles.

NEW POWER — NEW PROFITS

Weight on Drivers	216,000 pounds	Diameter of Drivers	84 inches
Weight of Engine	412,000 pounds	Boiler Pressure	300 pounds
Cylinders	25 x 29 inches	Tractive Power	55,000 pounds

AMERICAN LOCOMOTIVE COMPANY
30 CHURCH STREET · NEW YORK · N.Y.

man of the finance committee and was elected chairman of that committee. Benjamin F. Fairless was re-elected president of the United States Steel Corporation of New Jersey and becomes the chief administrative officer. Mr. Fairless is also president of the United States Steel Corporation of Delaware, the management corporation, with which the principal manufacturing subsidiaries have management contracts, with headquarters at Pittsburgh, Pa. Philip R. Clarke, president of the City National Bank & Trust Company of Chicago, was elected a member of the board of directors to succeed E. J. Buffington, deceased.

◆

THE JONES & LAUGHLIN STEEL CORPORATION, Pittsburgh, Pa., has appointed three new assistant general managers of sales; opened a new district sales office at Baltimore, Md., and made promotions and new appointments in several of its district sales offices. R. T. Rowles has been appointed assistant general manager of sales and will supervise the general activities of the hot-rolled, cold-finished, wire-products, and warehouse-sales departments. He entered the service of Jones & Laughlin in 1912 and in 1925, was appointed manager of hot-rolled sales. W. H. Wiewel has been appointed assistant general manager of sales and will supervise the general activities of by-products and pig-iron, sheets-and-strip, tinplate, and tubular-products sales departments. He joined Jones & Laughlin in 1935 as manager of sales of tubular products and had previously entered the steel business in 1910, with the Cambria Steel Company. H. J. Watt has been appointed assistant general manager of sales and will have charge of New York City and the East, with general supervision over district sales offices in Boston, Mass., New York, Philadelphia, Pa., Atlanta, Ga., and the new district sales office in Baltimore. Since 1935, Mr. Watt has served as district sales manager at New York. He entered the steel business in 1912, in the Philadelphia office of the Carnegie Steel Company and since 1925 has been in the service of Jones & Laughlin. Arthur A. Wagner, assistant manager of hot-rolled sales, has been appointed manager of hot-rolled sales, succeeding Mr. Rowles; John O'H. Anderson, assistant district sales manager at New York, has been appointed manager of sales, tubular products, succeeding Mr. Wiewel, and E. J. Dickson has been appointed assistant manager of sales, tubular products, at Pittsburgh. The following have been appointed district sales managers: V. A. Jevon, at Baltimore, Md.; John B. DeWolf, Philadelphia, Pa.; Edward H. Hughes, St. Louis, Mo.; Thomas C. Ham, having been transferred from Philadelphia to Pittsburgh, to supervise the corporation's industrial training plan, J. B. Hungate having resigned. Assistant district sales managers have been appointed as follows: H. R. Dorney, at Baltimore; Herbert B. Spackman, Philadelphia; William K. Breeze, New York; Hughart R. Laughlin, New York; F. B. Kittredge, Boston, Mass., and Charles M. Mason, Buffalo, N. Y.

Obituary

HAROLD A. KNAPP, vice-president and general sales manager of the Celotex Corporation, Chicago, died on March 24 at Waukegan, Ill., of a heart ailment.

◆

JOHN E. BRADLEY, former president of the Osgood Bradley Car Company, Worcester, Mass., died on April 4, at the age of 78, while vacationing in Bermuda. The business was founded by his grandfather as a stage coach manufacturer in 1848, and later developed into the production of railroad cars and trolley equipment. The company was sold in 1930, and is now part of the Pullman-Standard Car Manufacturing Company.

Personal Mention

General

C. P. VAN GUNDY, engineer of tests of the Baltimore & Ohio at Baltimore, Md., is retiring after 46 years of service.

J. H. MCGOFF, mechanical superintendent of the mechanical district, Eastern lines, of the Atchison, Topeka & Santa Fe at Shopton, Iowa, is retiring, at his own request, after 35 years' service.

EUGENE B. MILLER, special inspector on the staff of George H. Emerson, chief of motive power and equipment of the Baltimore & Ohio, has retired. Mr. Miller had been in the service of the B. & O. for over 51 years.

J. P. MORRIS, mechanical assistant in the general office of the Atchison, Topeka & Santa Fe at Chicago, has been appointed mechanical superintendent of the Eastern mechanical district of the Eastern lines, with headquarters at Shopton, Iowa, to succeed J. H. McGoff.

OLIVER C. CROMWELL, assistant to chief of motive power and equipment of the Baltimore & Ohio, with headquarters at Baltimore, has retired after 58 years of active service. Mr. Cromwell was born in Baltimore on August 29, 1860, and entered the service of the Baltimore & Ohio as an apprentice draftsman on July 1, 1878. He was mechanical engineer from 1900 to 1918, when he became assistant to general superintendent of motive power and equipment. In February, 1921, he was appointed assistant to chief of motive power.

THEODORE OLSON, master mechanic, Chicago Great Western, Oelwein, Iowa, has been appointed superintendent motive power, succeeding H. W. Reinhardt, who has resigned.

A. B. COLVILLE, superintendent of shops at Hillyard, Wash., for the Great Northern, has been appointed superintendent of motive power at Spokane, Wash., succeeding A. B. Ford.

W. R. HEDEMAN, assistant to chief of motive power and equipment of the Baltimore & Ohio, at Baltimore, Md., has been appointed engineer of tests, with the same headquarters, succeeding C. P. Van Gundy.

EDMUND E. CHAPMAN, engineer of tests of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan., has been appointed mechanical assistant to the assistant to the vice-president, with headquarters at Chicago, succeeding J. P. Morris. Mr. Chapman will continue to serve as engineer of tests. He was born on January 3, 1884, at Mankato, Kan., and was educated in the Concordia (Kan.) high school and at Purdue University, graduating from the course in mechanical engineering in 1907. After serving briefly with the Erie as a special apprentice, Mr. Chapman entered the service of the Santa Fe in December, 1909, as an assistant in the test department at Topeka. Following military service as captain and major in the ordnance department, he returned to the Santa Fe in June, 1919, as assistant engineer of tests, and became engineer of tests on March 1, 1921.

Master Mechanics and Road Foremen

L. W. GOODRICH, acting master mechanic of the Atchison, Topeka & Santa Fe at Chicago, has been appointed master mechanic.

J. P. BECKER, general locomotive and boiler inspector of the Chicago Great Western at Oelwein, Iowa, has been appointed master mechanic at Oelwein to succeed Theodore Olson.

W. V. HINERMAN, assistant master mechanic of the Cincinnati Division of the Chesapeake & Ohio, has been appointed master mechanic of the Hinton Division, with headquarters at Hinton, W. Va. The jurisdiction of the Hinton division had temporarily been in the hands of J. D. Davenport who is now master mechanic of the Clifton Forge Division.

Car Department

THOMAS H. RUSSUM, supervisor of passenger-car maintenance of the Baltimore & Ohio at the Mt. Clare (Baltimore), Md., shops, has retired after 54 years of continuous active service.

P. H. MITCHELL, general car inspector of the Delaware, Lackawanna & Western, with headquarters at Scranton, Pa., has been appointed master car builder, with the same headquarters.

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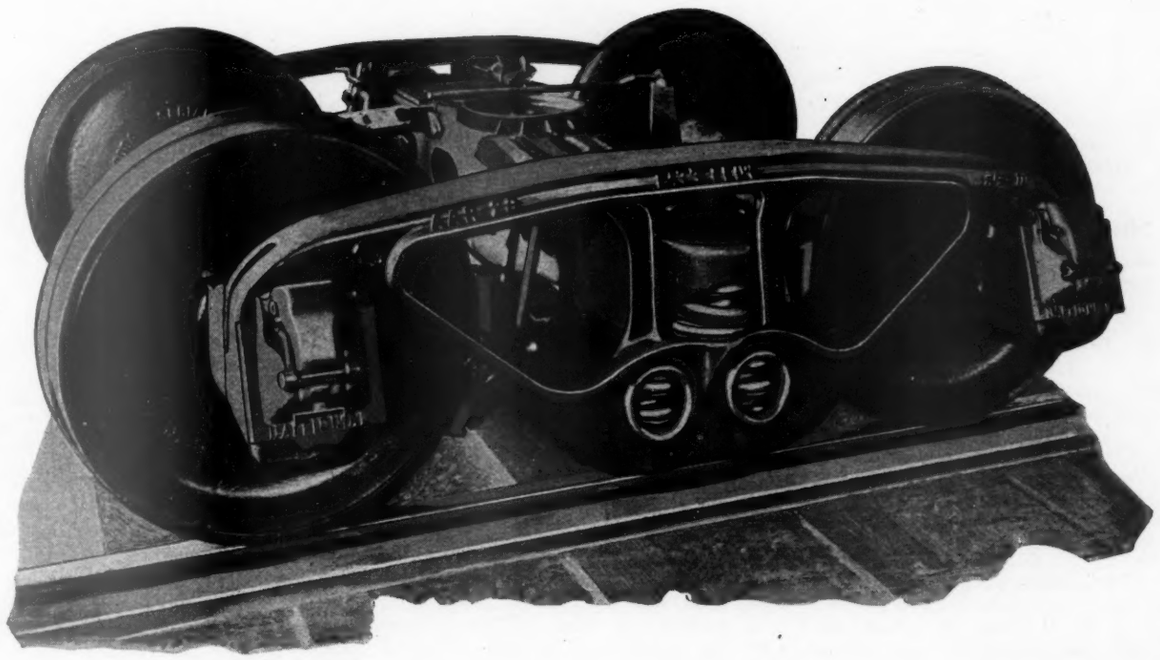
Note This

NATIONAL TYPE B

SPRING—PLANKLESS TRUCK



The Pioneer in Modern Truck Design Now in the Seventh Year of Production.

MAXIMUM availability and minimum operating expense of your freight cars are notable achievements obtained by National Type B Spring-Plankless Trucks.

Cars are rewheeled in shortest possible time, a matter of minutes instead of hours due to the simple construction—Spring breakage is minimized and spring loss entirely prevented with the enclosed design found only in National Type B Trucks.

All mechanical features are in advance of designs that have make-shift arrangements to eliminate the spring plank. These features have been embodied in the National Truck for over six years, making it the most reliable money-saving truck for your freight cars.

NATIONAL MALLEABLE AND STEEL CASTINGS CO.

General Offices: CLEVELAND, OHIO

Sales Offices: New York, Philadelphia, Chicago, St. Louis, San Francisco.

Works: Cleveland, Chicago, Indianapolis, Sharon, Pa., Melrose Park, Ill.

Canadian Representatives: Railway and Power Engineering Corporation, Ltd., Toronto and Montreal

WILLIAM H. PIRIE, general car foreman of the Canadian National at Halifax, N. S., has retired.

EDWARD M. JENKINS, who has been appointed master car builder of the Delaware, Lackawanna & Western at Scranton, Pa., as noted in the April issue, was born on June 28, 1886, at Vermont, Ill., and was educated in the public schools and the University of Illinois. From July, 1909, to September, 1911, Mr. Jenkins served as special apprentice for the Baldwin Locomotive Works and from the latter date until July, 1926, successively, as draftsman on the Baltimore & Ohio, chief draftsman for the Seaboard Air Line, mechanical engineer for the Virginian and special mechanical inspector for the Chesapeake & Ohio. In July, 1926, Mr. Jenkins was appointed chief draftsman, car department, Delaware, Lackawanna & Western and in May, 1927, became master car builder at Scranton.

Shop and Enginehouse

W. H. SHOW, foreman of the Norfolk & Western at Eckman, W. Va., has retired.

A. A. BURKHARD, superintendent of shops of the Merchants Despatch Transportation Corporation at East Rochester, N. Y., has retired.

EARL C. KELLOCK has been appointed enginehouse foreman of the Canadian National, with headquarters at Stellarton, N. S., succeeding James Blair, retired.

ROBERT R. ROYAL, who has been appointed shop superintendent of the Illinois Central with headquarters at Paducah, Ky., was born at Water Valley, Miss., on August 10, 1881. He attended high school and night school and entered railway service as a machinist apprentice on the Illinois Central on October 1, 1898. Upon the completion of his apprenticeship in 1902, he served as a machinist, first at Water Valley and then at McComb, Miss. From June, 1903, until September, 1904, Mr. Royal was employed, successively, by the Colorado Southern at Trinidad, Colo., the Southern Pacific at Sacramento, Calif., the Nashville, Chattanooga & St. Louis, at Nashville, Tenn., and the Southern at Atlanta, Ga. He then returned to the Illinois Central as a machinist and in September, 1907 became a machinist and foreman on the Missouri Pacific. He subsequently became a foreman on the Mobile, Jackson & Kansas City at Louisville, Miss., reentered the service of the Illinois Central as a machinist at Water Valley in July, 1908, and in April of the following year was promoted to gang foreman. In July, 1910, he was transferred to Durant, Miss., as district foreman, and in March, 1911, became enginehouse foreman at Water Valley. He subsequently became a machinist in the employ of the Southern at Princeton, Ind.; the St. Louis-San Francisco, and the Atlantic Coast Line at Waycross, Ga. He then served as a foreman of the St. L.-S. F. at Memphis, Tenn., becoming enginehouse foreman of the Illinois Central at Water Valley in January, 1913. In January, 1916, he was promoted to the position of general foreman at Water Valley; in October, 1917, was transferred to McComb, Miss., as general foreman, and on August 15, 1927, was transferred to Paducah, Ky., as general foreman. In December, 1929, he became master mechanic at Paducah and in January, 1938, was appointed shop superintendent at Paducah.

Robert R. Royal

Obituary

FRANK J. O'CONNOR, assistant purchasing agent of the Chicago, Milwaukee, St. Paul & Pacific at Chicago, died at Phoenix, Ariz., on March 24.

J. E. WHITE, who retired on June 1, 1931, as master mechanic of the Louisville & Nashville at Pensacola, Fla., died in that city on March 22 at the age of 75.

ERNEST F. STROEH, formerly mechanical superintendent of the Missouri Pacific at St. Louis, Mo., who retired in April, 1932, as master mechanic, died in Denver, Colo., on March 17. He was 63 years of age.

H. S. BURR, formerly general superintendent of stores of the Erie, who retired from active service in 1931, died at Hornell, N. Y., on March 23. Mr. Burr was a past president of the Railway Storekeepers Association.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

CERTIFIED STEELS.—Joseph T. Ryerson & Son, Inc., Chicago. 28 pages, illustrated. Describes Ryerson system of furnishing quality-controlled steels from stock; specifications and suggestions for heat treaters.

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SPRAY-FINISHING EQUIPMENT.—The DeVilbiss Company, Toledo, Ohio. Catalog "ID". 28 pages, illustrated. Covers complete DeVilbiss line of industrial spray-painting and finishing equipment and gives full specifications on all standard items.

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FUNDAMENTALS OF GOOD REFRIGERATOR INSULATION.—Dry-Zero Corporation, Merchandise Mart, Chicago. 44 pages. Explains theory of insulation and its application to all types of refrigerated and air-conditioned containers, including railroad passenger and refrigerator cars. Sections deal with insulating materials; influence of moisture, and test results obtained by Dr. J. L. Finch at U. S. Bureau of Standards.

WELDING INSTRUCTIONS AND STANDARDS.—United States Steel Corporation Subsidiaries, Box 176, 434 Fifth avenue, Pittsburgh, Pa. Part I, Symbols and Method of Showing Welding on Drawings. 81 pages, spiral bound. Price, 50 cents. First of a series dealing with all phases of welding; others soon to be issued.

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ENGINEERING DATA FILE.—Packless Metal Products Corporation, Long Island City, N. Y. Bulletin 100. Descriptive matter and specification data sheets on Packless seamless flexible metal hose, detachable self-sealing couplings, self-flaring tube couplings and copper tubing.

AMMONODUCT.—Bethlehem Steel Company, Bethlehem, Pa. Four-page illustrated folder describing a special fatigue-resisting pipe for freight- and passenger-car air lines, and for locomotive water, air and steam lines.

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"THE STORY OF THE BRAKE SHOE."—The American Brake Shoe and Foundry Company, 230 Park avenue, New York. 52 pages, illustrated. A historical record of braking in general and the development of a satisfactory composition and shape for standard railroad brake shoes in particular.

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TURRET LATHE TOOLS.—The Warner & Swasey Company, Cleveland, Ohio. Catalog and Manual No. 38, 176 pages, wire bound. Chucking tools, bar tools, cross-slide tools, holding devices, and semi-standard and special tools. Machine data sheets, speed and feed charts, diagonals of hexagons and squares, etc.